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SILVA (P.). **Insect Pests of Cacao in the State of Bahia, Brazil.**—*Trop. Agriculture* **21** no. 1 pp. 8–14, 20 refs. Trinidad, 1944.

Notes are given on a large number of insects that attack cacao in Bahia, but only the major pests are dealt with in any detail. These comprise *Selenothrips rubrocinctus*, Giard, Capsids of the genus *Monalonion* [*R.A.E.*, A **27** 566], and the leaf-cutting ants, *Atta cephalotes*, L., and *Acromyrmex subterraneus* var. *brunneus*, Forel. The minor pests include *Stenoma decora*, Zell., which bores in the pods and is considered of potential importance. Specimens of a Longicorn from Bahia that was stated to have damaged weakened cacao trees and was identified as *Steirastoma depressum*, L., were found to differ from Trinidad specimens of *S. depressum* and a distinct species may therefore be involved. In a short discussion of possible control measures against cacao pests, biological and cultural methods are stated to be more practicable under conditions in Bahia than insecticides.

FERRIS (G. F.). **The Genus *Targionia* Signoret and some of its Allies (Homoptera: Coccoidea: Diaspididae).**—*Microentomology* **8** pt. 3 pp. 82–100, 10 figs., 1 map. Stanford Univ., Calif., 1943.

This paper includes definitions of the genera *Targionia*, *Quadraspidiotus* and *Rhizaspidiotus*, of which the respective types are *T. nigra*, Sign., *Aspidiotus ostreaeformis*, Curt., and *A. dearnessi* Ckll. (*helianthi*, Parrott), lists of the synonyms of these genera, a discussion of the geographical distribution of *Targionia*, a list of species that have been correctly or incorrectly described in or referred to *Targionia*, showing their generic assignments, a list of the species included by the author in *Targionia*, with notes on their synonymy, food-plants, distribution and morphological characters and a key to them, a similar list of the species of *Quadraspidiotus* that have been described in or referred to *Targionia*, and a list of the species of *Rhizaspidiotus*.

PARKIN (E. A.). **The Depletion of Starch from Timber in Relation to Attack by *Lyctus* Beetles. V. The Effect upon Starch Content of storing Timber in the Log.**—*Forestry* **17** pp. 61–66, 9 refs. London, 1943.

This part of a series on practical methods of reducing the starch content of timber with a view to rendering it immune from attack by species of *Lyctus* [*cf. R.A.E.*, A **28** 450, etc.] deals with the depletion of starch from logs stored under laboratory and commercial conditions. Observations on short lengths of oak, ash and walnut branchwood, 3–4 ins. in diameter, showed that depletion from the sapwood proceeds as long as the wood retains sufficient moisture for the cells to remain alive, occurring fairly rapidly at the temperatures of an English summer, but slowly during winter in samples stored out of doors. Immunity from infestation by *Lyctus brunneus*, Steph., was acquired in 5–9 months. The risk of fungal stain or decay during the process of depletion depends on the species of timber and the conditions under which it is kept, but it appears that oak and ash are likely to be amenable to treatment involving log storage, but that difficulty may be experienced with walnut, owing to a discoloration that appears concurrently with the beginning of depletion or soon after it; such a stain might not, however, be important commercially.

Observations on stored oak and ash logs showed that the relatively narrow band of sapwood on the former could generally be rendered starch-free by storage in the open or under cover for twelve months, irrespective of whether the bark was present or not, whereas the ash logs usually possess a wide band of starch-containing tissues and cannot normally be depleted of starch by storage under natural conditions for a year; there is no advantage in longer storage. In

England, the risk of serious injury to timber stored in logs from stain and decay or from insect attack is not great, except in certain parts of the south, where oak logs are liable to severe infestation by *Platypus cylindrus*, F. [*cf.* **28** 453].

THOMPSON (W. L.). **Control of the Citron Plant Bug on** *Citrus*.—*Pr. Bull. Fla. agric. Exp. Sta.* no. 555, 2 pp., 2 refs. Gainesville, Fla., 1940. [Recd. 1944.]

A considerable amount of injury to fruits of *Citrus* in Florida is sometimes caused by adults of *Leptoglossus gonagra*, L. [*cf. R.A.E.*, A **23** 199], which cluster and suck the juice from tangerines and early oranges until they wither and drop ; minor injury on green fruit ranges from yellow spots to premature coloration. This Coreid breeds in decayed fruits of the citron melon (*Citrullus vulgaris*), and such fruits may be numerous in *Citrus* groves after they have been broken during cultivation. They are most suitable when little remains but shell and seeds ; these fruit shells harbour nymphs and adults in the late summer and early autumn. By September and October, adults are abundant and active on the wing in the heat of the day. Control has been effected in a commercial grove by shaking the bugs from the *Citrus* fruits into a pan of oil during the cool hours of the morning. Most of the infested fruits are on the lower branches and so can be reached by a man of average height. To prevent reinfestation, adults on the citron vines should be collected in nets and the nymphs killed by trampling or spraying with oil. Damage will be avoided if the citron vines are eliminated from the grove, but this usually takes several years. During the process the young vines should be destroyed each year before they fruit, and the fruits should be collected before they are broken by cultivation.

RAHMAN (K. A.). **Annual Report on the Combined Entomological Scheme, Punjab and N.-W. F. Province for the Year 1938–39.**—[1+] iii+17 pp., 2 refs. Lahore, 1939. **Final Report on the Combined Entomological Scheme, Punjab and N.-W. F. Province.**—[1+] 50+iv pp., 3 refs. Lahore, 1940. [Recd. 1944.]

These intermediate and final reports describe the completion of work begun in 1937 [*R.A.E.*, A **27** 503] on a combined survey of insect pests of fruit trees in the Punjab and the North-West Frontier Province. The final report contains a comprehensive record of the insect pests and the plants on which they were found, with notes on the bionomics of some of them ; information taken from the author's summary has already been noticed [**30** 612]. *Parlatoria cinerea*, Hadden (*pseudopyri*, Kuw. & Muramatsu) recorded in 1940 for the first time in India, was found on apple, mango and other plants in many districts in both provinces. *Cydia pomonella*, L., was intercepted on fresh fruits imported from Afghanistan and on fresh crab-apples distributed from the Kurram Valley to other parts of the North-West Frontier Province and the Punjab. Insects intercepted on dried fruits imported from Afghanistan and Baluchistan are noted, and some account is given of limited experiments in fumigating nursery stock.

HWANG (Shui-Lwen) & CHANG (Sing-Chen). **Recent Work in agricultural Chemistry in China.**—*Acta brevia Sinensia* no. 4 pp. 7–9 multigraph, 8 refs. [London] British Council, 1943.

In the section of this paper dealing with insecticides, the authors record that cotton-seed oil emulsion gave effective control of *Aphis gossypii*, Glov., on cotton in Kwangsi ; the emulsion is made by mixing the crude cotton-seed oil, which always contains a small quantity of free fatty acid, with sodium carbonate. The roots of *Derris elliptica*, which was introduced into Kwangsi

Province and has flourished there, were found to have a rotenone content of about 6 per cent., and the seeds of *Pachyrhizus erosus* one of 1·6 per cent. [*cf. R.A.E.*, A **30** 419; **31** 502; **32** 277]. Preparations of the latter have given effective control of Aphids and soft-bodied insects, such as *Phyllotreta vittata*, F., and *Aulacophora* (*Ceratia*) *orientalis*, Hornst. Seeds of *Millettia pachycarpa* collected from markets in Yunnan have been reported to contain 11 per cent. rotenone.

LEVER (R. J. A. W.). **Entomological Services in Fiji.**—*Agric. J. Fiji* **14** no. 4 pp. 92–97, 20 refs. Suva, 1943.

In this paper, some account is given of entomological work in Fiji since 1906. That of outstanding importance comprises the biological control of the coconut pests, *Levuana iridescens*, B.-B., by *Ptychomyia remota*, Aldr. [*R.A.E.*, A **18** 510], *Aspidiotus destructor*, Sign., by Coccinellids, notably *Cryptognatha nodiceps*, Mshl. [**23** 279], *Tirathaba trichogramma*, Meyr., by parasites introduced from Java [**23** 608], and *Promecotheca reichei*, Baly, by *Pleurotropis parvulus*, Ferrière [**25** 191], and of the noxious weed, *Clidemia hirta*, by means of *Liothrips urichi*, Karny [**21** 625, etc.].

MUGGERIDGE (J.). **The White Butterfly (*Pieris rapae* L.). I. Its Establishment, Spread and Control in New Zealand. II. Parasites of the Butterfly. III. Introduction of Parasites, Method and Technique.**—*N. Z. J. Sci. Tech.* **24** no. 3A pp. 107A–129A, **25** (A) no. 1 pp. 1–18, 18–30; 23 figs., 29 refs. Wellington, N. Z., 1943.

The first of these three papers contains accounts of the world distribution and bionomics of *Pieris rapae*, L., all stages of which are described, and of its establishment and spread in New Zealand, into which it was introduced in 1930 [*R.A.E.*, A **19** 619]. Lettuce is commonly recorded as one of its food-plants [*cf.* **27** 344], but in 12 experiments in which larvae were transferred to lettuce plants in batches of six, no evidence of feeding was observed, and most of the larvae died of starvation, though a few pupated. It was found that initial infestation of a crop of crucifers is usually confined to the edges of the field, probably because the butterflies mate and feed on plants outside it and the females oviposit on the first available food-plants. This may afford an opportunity for control before the whole field becomes infested by subsequent generations. Initial infestation is likely to extend further into fields with many weeds and in which the growth is uneven, partly because of the greater distance between plants suitable for oviposition and partly because flowering weeds attract the adults. In studies on the life-cycle at Palmerston North, North Island, in 1933–34, three complete generations and a partial fourth occurred during the year. The thermal constants for the egg, larva and pupa are 56·4, 217 and 150·1 day-degrees Centigrade [101·52, 390·6 and 270·18 day-degrees Fahrenheit], with thresholds of development of 8·4, 6·0 and 7·0°C. [47·12, 42·80 and 44·60°F.], respectively. The figures for the egg were obtained from experimental evidence, and those for the larva and pupa are taken from a paper by Peairs [**16** 642]. The numbers of generations likely to occur at 22 places, 11 in each Island, calculated from these figures and meteorological data from the places concerned, are given in a table and range from one to five. The distribution of cruciferous crops and of rainfall in the two Islands is shown on maps and, together with the temperatures, discussed. Crucifers are grown chiefly in areas of low rainfall, and damage by insects, of which the principal species are *Plutella maculipennis*, Curt., *Brevicoryne brassicae*, L., *Pieris rapae* and *Odontria zealandica*, White, is most severe in these areas.

The second paper contains a list of the recorded parasites of *P. rapae* and detailed accounts of the introduction and establishment in New Zealand of

Apanteles glomeratus, L., and *Pteromalus puparum*, L. [**22** 724 ; **28** 27, etc.], together with notes on their bionomics, mostly from the literature. Field surveys during the four years since the liberation of the strain of *A. glomeratus* introduced from the United States [**28** 28] indicate that it is becoming established [**31** 526 ; **32** 78]. The decrease in parasitism by *P. puparum* and the increase in numbers of *Pieris rapae* noted in 1935 [**25** 80] continued in 1936–37. Furthermore, in these years, parasitism was again found to be higher among pupae in relatively exposed and dry situations than among those in damp and sheltered positions, though there had been little difference in previous years. It is therefore concluded that *Pteromalus puparum* is likely to prove most effective in dry districts.

In the third paper, the methods of handling the imported parasites and the technique used for the mass-rearing of *P. puparum* are described in detail, and lists are given of the hosts of *A. glomeratus* and *P. puparum*. As parasitism by the latter tends to fall temporarily under wet conditions and some damp areas occur in the regions of low rainfall where cruciferous crops are most important, the introduction of further larval parasites, of which *A. rubecula*, Marsh., *Zenillia* (*Phryxe*) *vulgaris*, Fall., and *Compsilura concinnata*, Mg., are considered suitable species, is proposed [*cf.* **29** 314, 333].

The question of the adaptation of *Apanteles glomeratus* to *Pieris rapae* is discussed in both the second and third papers. There is much evidence to support the view that it normally attacks *P. rapae* only where it is numerous as a parasite of *P. brassicae*, L. [*cf.* **7** 397 ; **24** 607 ; **29** 314], but it is an important parasite of *P. rapae* in Japan [**21** 358], Hawaii and North America, where *P. brassicae* is absent. This, and the establishment of an American strain in New Zealand, suggest that it may have produced a race adapted to *P. rapae*. It has been recorded as a parasite of two indigenous species of *Pieris* in North America, and may have become adapted to *P. rapae* after breeding in these. On the other hand, there is the possibility that *P. rapae* in North America was in fact controlled by an indigenous species of *Apanteles* modified to resemble *A. glomeratus* as a result of breeding in this host or even by a hybrid between *A. glomeratus* and an indigenous species.

[Vladimirskaya (N. S.).] **Владимирская (Н. С.). The Causes of the Redistribution of toxic Principle in Dust Preparations.** [*In Russian.*]—*Med. Parasitol.* **11** no. 5 pp. 88–89, 2 graphs. Moscow, 1942. [Recd. 1944.]

It has been often observed in agricultural practice in Russia that a sample of a dust insecticide taken from the upper part of the drum in which it is kept is ineffective against an insect pest, whereas a sample from the bottom kills the insect and also scorches the plants. The experiment described indicated that this is due to the shifting of particles in the stored material. Calcium arsenite was kept in two jars in the laboratory ; one jar was shaken vigorously at intervals and the other was not, but was subject to vibration owing to the movements of people in the room and the passage of trams in the street. In the case of each jar, periodical analysis showed an increasing arsenic content in dust from the lower part and a decreasing one in dust from the upper part. Further examination showed that the dust was a mixture of fine and relatively coarse particles, with average arsenic contents of 71·6 and 64·5 per cent., respectively.

Rahman (K. A.) & Abdul Wahid Khan. **Preliminary Observations on the Insect Pests of dry Fruits, Oat Meal and Army Biscuits and their Control.**—*Proc. Indian Acad. Sci.* Sect. B **19** no. 1 pp. 1–8, 1 fig., 2 refs. Bangalore, 1944.

A list is given of 15 species of insects recently found in the Punjab infesting stored products, chiefly dried fruits and cereals. Those of importance as pests

are *Oryzaephilus surinamensis*, L., *Attagenus piceus*, Ol., *Stathmopoda trissorrhiza*, Meyr., *Ephestia cautella*, Wlk., *Corcyra cephalonica*, Staint., and *Sitotroga cerealella*, Ol. *O. surinamensis* was found in many dried fruits, walnuts, semolina, biscuits, garlic, melon seeds and cacao, and breeds from April to November. In experiments, females laid 46–185 eggs singly in tunnels in dried fruits and the larvae fed and pupated in them. The egg, larval and pupal stages lasted 7–14, 32–39, and 13–20 days. The larvae of *A. piceus*, which also infested dried fruits, avoid light and cling to rough surfaces. Infested material should be spread on a sheet of paper and after all the larvae have clung to it the material should be shaken into another sheet. *Stathmopoda trissorrhiza* was first found in October 1942 causing serious damage to raisins and dried dates. It is active from April to October, and the larvae hibernate. *E. cautella* was taken in stored apples in January 1936, and in dried apricots in March 1943. *C. cephalonica* attacked raisins as well as cereals ; the females laid up to 115 eggs either singly or 3–4 together, and the egg, larval and pupal stages lasted 6–7, 20–28 and 10 days. *Sitotroga cerealella* infested chillies and compressed white oats in tins. The life-cycle was completed in 35–39 days in summer and the larvae hibernate.

Methods that were investigated for control of pests of stored products as alternatives to fumigation with hydrocyanic acid gas or carbon bisulphide, were careful packing, and exposure to various gases or to heat. Oxygen was useless ; chlorine, ammonia and hydrogen sulphide destroyed all stages of the insects, but rendered dried fruits unfit for consumption. Exposure for 96 hours to carbon dioxide killed all insects and did no harm to the dried fruits. Sulphur dioxide and methane both killed all stages of the insects, and the odour they imparted to the fruits was removed by airing in sunlight for two hours. Dried fruits were exposed to heat in a closed iron box standing in a larger one containing water heated by a fire. A thermometer was inserted among the fruits through holes in the lids of both boxes, and another pair of holes permitted the escape of steam. The lethal exposures were 1 hour at 48°C. [118·4°F.] for *E. cautella*, *Stathmopoda trissorrhiza*, *C. cephalonica* and *O. surinamensis* and two hours at 66°C. [150·8°F.] for *Tribolium castaneum*, Hbst. Manufacturers of food products should superheat main stores before storage and fumigate afterwards with hydrocyanic acid gas. Before packing, the material should be treated by heat, packed immediately and similarly treated after packing. Packing cases should be of tin, or hard cardboard cartons wrapped in celluloid paper, if tin is not available. Products may also be efficiently preserved in an atmosphere of carbon dioxide in tin containers. The gas should be liberated in the tins immediately after packing and the tins sealed.

Résumé of the Work done at the Sugarcane Research Station, Bihar, during 1939–40.—*Rep. agric. Dep. Bihar 1939–40* pp. 69–75. Patna, 1943.

A survey of the insects attacking sugar-cane in Bihar, showed that almost all the major Indian pests occur in the province, including *Argyria tumidicostalis*, Hmps., which has not previously been recorded there. *Scirpophaga nivella*, F., attacked the largest number of canes and internodes, but *Proceras* (*Diatraea*) *auricilius*, Dudgn., bored the maximum length of cane tissue ; *Emmalocera depressella*, Swinh., caused least damage. Heavy soil appeared to favour infestation by *Proceras* but retarded activity of *Emmalocera*, and water-logging and flood conditions had no effect on the latter, but resulted in greater infestation by *Scirpophaga* and *Proceras*. Attack by *S. nivella* was least in the summer, but reached a peak in September, whereas *P.* (*A.*) *sticticraspis*, Hmps., was most active during the summer and killed many young plants. *P. auricilius* generally attacked mature canes, particularly in autumn, after the monsoon, and *E. depressella* was active throughout the year, but was most injurious to the young

plants. Combined borer attack resulted in the loss of 5·7 per cent. in tonnage and 0·43 per cent. in sugar recovery.

Brücher E. (G.). **Lista de algunos nombres vulgares de insectos.** [A List of some popular Names of Insects.]—*Bol. Dep. Sanid. veg.* **2** no. 2 pp. 120–125. Santiago, Chile, 1943.

A list is given of the scientific and Spanish names of approximately 200 species of insects and mites that are injurious or beneficial to agriculture in Chile or to agricultural products imported into the country.

Stuardo O. (C.). **Un Calliphoridae (Díptera) que debe incorporarse a la fauna chilena.**—*Bol. Dep. Sanid. veg.* **2** no. 2 p. 132. Santiago, Chile, 1943.

The author reports that *Sarcophaga* (*Acridiophaga*) *caridei*, Brèth., described as a parasite of *Schistocerca paranensis*, Burm., in Argentina, was bred from two other Acridids, *Trimerotropis ochraceipennis*, Blanch., and *S. cancellata*, Serv., in Chile in March 1936 and November 1937, respectively.

Principales plagas agrícolas producidas por insectos y otros animales que fueron objeto de consulta en el primer semestre (Enero a Junio) [y] en el segundo semestre (Julio-Diciembre) de 1942. [The principal Injuries to Crops caused by Insects and other Animals that were reported in Chile in the first and second Halves of 1942.]—*Bol. Dep. Sanid. veg.* **2** nos. 1 & 2 pp. 61–63, 158–162. Santiago, Chile, 1943.

These further lists [*cf.* *R.A.E.*, A **31** 207, etc.] include records of injurious insects, with their food-plants and the localities in which they were observed, and of a few parasites and predators, with the insects they attacked.

Campaña de erradicación de la mosca de la fruta en la ciudad de Arica y valles de Azapa, Codpa y Timar. [A Campaign to eradicate the Fruit-fly in the City of Arica and the Valleys of Azapa, Codpa and Timar.]—*Bol. Dep. Sanid. veg.* **2** no. 2 pp. 175–180. Santiago, Chile, 1943.

In 1934–35, attempts were made to eradicate fruit-flies [*Anastrepha*] from the valleys of Azapa and Codpa in the Department of Arica by ensuring the absence of all fruit in which they could oviposit and by carrying out direct measures against the larvae, pupae and adults. All fruit trees and bushes were pruned, garden crops were uprooted and the natural herbaceous and shrubby vegetation was cut down or uprooted, all the existing fruit being collected and burnt or buried under at least 20 inches of soil. The soil beneath the fruit trees was removed, and any pupae discovered were destroyed, the plants were frequently sprayed with insecticides, and traps containing poison baits were maintained. In addition, all vehicles and baggage animals entering the valleys were inspected to prevent the unauthorised entry of fruit and other merchandise suitable for oviposition, and all houses in the infested district were searched for hidden fruit on which the insects might develop. The same measures were carried out in the town of Arica, and the exposure of fruit in the shops was forbidden.

After this period, routine measures, including control of all imported vegetable products, particularly fruit, the inspection of fruit trees and wild and cultivated plants liable to infestation and of the ground below the fruit trees, the installation and regular inspection of bait traps, harvesting the various fruits grown in the valley on fixed dates, and the collection and destruction or burial of overripe fruits from the trees or the ground, were continued. Further infestations were discovered in the Azapa valley in 1940 and in the Codpa and Timar valleys in 1941, and eradication campaigns were therefore carried out in the three valleys from October 1940 to May 1941, from May 1941 to January 1942 and from

July 1941 to January 1942, respectively. More foci of infestation were found in the Azapa valley in May 1942, and measures of eradication were again repeated, with the result that the number of fruit-flies caught in bait-traps fell from 42 in the first half of the year to 5 in the second, the last being observed on 21st October.

The measures employed in the three valleys are summarised in tables.

Campaña contra el bruco del frejol, en el valle de Limache. [A Campaign against the Bean Bruchid in the Limache Valley.]—*Bol. Dep. Sanid. veg.* **2** no. 2 pp. 181–183, 2 refs. Santiago, Chile, 1943.

The campaign against *Bruchus* (*Acanthoscelides*) *obtectus*, Say, in the Limache valley [*cf. R.A.E.*, A **32** 100] was continued in 1942 without fundamental change. The measures used consisted in preventing the unofficial transport of beans into or out of the infested zone ; fumigating ; rationing the quantities distributed to the population for food, to prevent accumulations liable to become infested ; examining warehouses ; destroying clandestine sowings ; employing trap cages and trap crops [*cf. loc. cit.*] ; and studying the biology of the Bruchid and its possible wild food-plants.

In September, infestations were found in two localities near the valley, and stored and growing leguminous crops in these districts were surveyed immediately and taken under control. These infestations were very light, but appeared to have been present for some time.

MacAloney (H. J.). **Relation of Root Condition, Weather, and Insects to the Management of Jack Pine.**—*J. For.* **42** no. 2 pp. 124–129, 1 fig., 12 refs. Washington, D.C., 1944.

Dead trees were noticed among mature stands of jack pine (*Pinus banksiana*) in the part of the Chippewa National Forest in Itasca County, northern Minnesota, in 1938, and in 1939, large numbers of trees were found to be decadent. Defoliation by the form of *Harmologa* (*Archips*) *fumiferana*, Clem., that attacks jack pine had been observed in 1937, when it was limited to a small proportion of the trees, chiefly those on which staminate flowers had been abundant, and it occurred over wide areas in 1938. Defoliation was complete in some isolated stands, where *Neodiprion banksianae*, Rohw., attacked the old leaves of trees on which the current foliage was destroyed by *H. fumiferana*. In 1939, infestation occurred over almost the entire region and extended into the eastern edge of the Cass Lake District, but both insects were less numerous, and defoliation was not sufficiently severe to kill the trees. As it has been shown that as a rule only the tops of jack pines attacked by *H. fumiferana* are killed [*cf. R.A.E.*, A **23** 698], and since mortality was not confined to trees of any one crown class, it was thought that factors other than defoliation were involved. Heavy mortality among *P. banksiana* in northern Minnesota in 1936 was apparently due to the combined action of defoliation by *H. fumiferana*, heat and drought, and previous work had shown insect attack to be secondary to physiological disturbances in causing mortality in birch and hemlock [*Tsuga*]. Investigations, which are described in detail, were therefore carried out with jack pines to determine whether similar physiological disturbances occurred in trees of varying vigour, as a result of which it was concluded that defoliation was not the primary factor causing mortality, but that it was probably important in the final stages of decadence in weakened trees.

Johnston (H. R.). **Control of the Texas Leaf-cutting Ant with Methyl Bromide.**—*J. For.* **42** no. 2 pp. 130–132, 1 fig. Washington, D.C., 1944.

In 1934, *Atta texana*, Buckley, which defoliates many kinds of plants in Texas and Louisiana, was found to be a serious pest of pine seedlings, many

thousands of which are destroyed by it each year. In experiments in the Kisatchie National Forest, Louisiana, in 1935–37, carbon bisulphide applied in winter at the rate of 2 oz. per application point at distances of 10 ft. over the area occupied by the colony gave effective control, but in view of its inflammable and explosive nature, other materials were tested, of which methyl bromide appeared the most promising. In April 1938, two colonies were eradicated by applying small quantities of it to tunnels 5–10 ft. apart throughout the area, the total amount used being 2 lb. for one colony and 3 for the other. In February 1940, five colonies were eradicated by its application at rates of ½, 1 or 2 oz. per tunnel in a number of tunnels in each colony, and an extensive colony was destroyed by using large quantities in a few tunnels. In November 1940, a medium-sized colony was eradicated by applying 4 oz. to each of the five tunnels near the centre. Despite its effectiveness, methyl bromide was considered impracticable for general use owing to the difficulty of application, but convenient and inexpensive equipment has since become available, and further tests were therefore carried out, in all of which the methyl bromide was released through rubber tubing about 2 ft. down into the tunnels. In March 1941, nine colonies received dosages varying from 1 lb. for those covering ¾–1½ acres to 2 lb. for one occupying 3 acres. In each colony, 1–4 entrance tunnels were treated, and in some cases these were then closed. The soil was wet and its temperature at a depth of 1 ft. was 52°F.; the atmospheric temperature was 58°F. A year later, six of the colonies had been eradicated, in each of two others only one active hole remained, and in the large one the central nest was completely destroyed, but several feeder holes were still active. It was concluded that the rate of application should be 1 lb. for colonies up to 1 acre in size and 1 lb. per acre for larger ones, that it is sufficient to treat only the central portion of a colony, and that the holes need not be closed after treatment. The colonies should be examined after several months and portions that are not eradicated should be treated again.

Carbon bisulphide and all the other materials tested are ineffective in warm weather, and methyl bromide gave poor results when applied to 34 colonies in July at soil and air temperatures of about 80–88°F. Some colonies were reduced but none was eradicated. The failure to obtain satisfactory control in summer is attributed to seasonal differences within the colony, possibly due to some of the queen cells being nearer the surface where they would escape the gas. The cost of application is not more than a quarter of that of carbon bisulphide.

ARK (P. A.). **Studies on bacterial Canker of Tomato.**—*Phytopathology* **34** no. 4 pp. 394–400, 12 refs. Lancaster, Pa., 1944.

Canker caused by *Phytomonas michiganensis* is the principal bacterial disease of field-grown tomatos in California. The investigations on it described in this paper included experiments in which the causal organism was not transmitted from infected to healthy plants by *Myzus persicae*, Sulz., *Lygus oblineatus*, Say (*pratensis*, auct.), *Thrips tabaci*, Lind., or *Diabrotica duodecimpunctata*, F., and was not isolated from the mouth-parts or the internal organs of the insects.

WISECUP (C. B.) & HAYSLIP (N. C.). **Control of Mole Crickets by Use of poisoned Baits.**—*Leafl. U.S. Dep. Agric.* no. 237, 6 pp., 2 figs. Washington, D.C., 1943.

Outbreaks of mole crickets, which damage vegetables and tobacco and often attack such crops as ground-nuts, strawberries and grasses, have occurred at various times and places in the South Atlantic and Gulf Coast States from North Carolina to Texas. *Scapteriscus acletus*, Rehn & Heb., is the most common and abundant species, and is accompanied by *S. vicinus*, Scud., in certain areas. These two species are commonly found in soils of the sandy type where

vegetables are grown commercially. *S. abbreviatus*, Scud., is found only in the southern third of Florida, and *Gryllotalpa hexadactyla*, Perty, is comparatively scarce except in a few localities with wet heavy soil. A brief account is given of the bionomics of the mole crickets, the damage they cause and methods of controlling them [*cf. R.A.E.*, A **31** 467 ; **32** 154]. A bait of 100 lb. dry wheat bran and 8 lb. sodium fluosilicate, moistened with 3–5 U.S. gals. water, should be scattered on the soil surface at the rate of 20 lb. dry bait per acre per application, as evenly as possible, since the mole crickets feed from temporary burrows and are not known to be attracted to small piles of food or bait. The most effective time for application is during August and September, when the nymphs are growing fast. A single application will kill only about 75 per cent. of the insects in any given area, since they do not all feed at the same time, and others may migrate from untreated areas, so that further treatments at intervals of about ten days, or when the soil surface is moist enough to encourage the mole crickets to feed, may be necessary. To reduce reinfestation, the bait should be scattered on adjacent roadways, ditch banks and empty fields for several yards round treated fields. It is more effective when applied after ploughing or disking than when ploughed under, and better results are obtained on bare fields than on fields covered with a heavy growth of weeds or grass.

Since a small number of mole crickets can cause serious injury in seed-beds, these should be treated with bait at the rate of 12 oz. per 1,000 sq. ft. some days before sowing, and several subsequent applications should be made at the rate of 8 oz. per 1,000 sq. ft. All applications should be made after rain or thorough irrigation, and the bait should not be allowed to touch the seedlings. Barriers of boards round the plots, set 10 ins. deep in the soil and extending at least 2 ins. above the surface, with tight-fitting joints and corners, will prevent many mole crickets from entering ; they are most effective in early spring, late summer and early autumn, when the winged adults are least numerous.

Smith (R. W.). **Observations on Parasites of some Canadian Grasshoppers.**—*Canad. Ent.* **76** no. 2 pp. 28–33. Guelph, Ont., 1944.

In order to study the part played by parasites in regulating the abundance of the various species of grasshoppers in Canada and the possibility of manipulating native parasites, or of introducing exotic ones, for more satisfactory control, an investigation was begun in 1938 by the Field Crop Investigations Unit of the Division of Entomology and the Parasite Laboratory of the Dominion Department of Agriculture. The investigation has so far been confined largely to the Prairie Provinces and has dealt mainly with the nymphal and adult stages of *Camnula pellucida*, Scud., *Melanoplus mexicanus*, Sauss., and *M. bivittatus*, Say, but some material has been collected from other Provinces, and many additional hosts have recently been studied. Preserved and live material has been sent from many collecting points to Belleville, and in 1941 some 14,000 specimens for rearing and 14,400 specimens for dissection were received. Although collections from Saskatchewan and Alberta had not been received when this paper was written, 17 species of parasites have been reared or dissected. Two of them, a species of *Perilampus* of the group of *P. hyalinus*, Say [*cf. R.A.E.*, A **29** 309] and *Brachymeria coloradensis*, Cress., are secondary parasites. The primary parasites are *Sarcophaga aculeata*, Aldr., *S. atlanis*, Aldr., *S. coloradensis*, Aldr., *S. hunteri*, Hough, *S. kellyi*, Aldr., *S. opifera*, Coq., *S. reversa*, Aldr., *S. sinuata*, Mg., the Tachinids, *Acemya tibialis*, Coq., *Ceracia dentata*, Coq., *Hemithrixion oestriforme*, Br. & Berg., and *Leucostoma atra*, Tns., the Anthomyiid, *Acridomyia canadensis*, Snyder, the Nemestrinid, *Trichopsidea* (*Parasymmictus*) *clausa*, O.-S., and a Mermithid, *Agamermis decaudata*. Tables show parasites recorded from 16 different hosts, and the distribution of records by Provinces. The only parasites not taken in western Canada (Manitoba) were *C. dentata* and *L. atra*.

The investigation showed that some grasshopper species are more resistant to parasites than others or even immune from either the attack or the establishment of a parasite. *M. bivittatus* shows considerable resistance to all the Sarcophagids, particularly *S. reversa* and *S. atlanis*, the latter apparently being unable to survive in this host, in which *Acridomyia canadensis* and the Tachinids suffer little mortality. *M. mexicanus* has shown host resistance only to *Sarcophaga* "B" (possibly *coloradensis*) and appears to be readily attacked by most of the other parasites. *Camnula pellucida* is very lightly parasitised, but shows little resistance to parasite development. *Sarcophaga* "B" and *S. reversa* appear in June, attacking grasshoppers of the second and later instars; *S. hunteri* and *S. atlanis* appear late in June and attack the fifth-instar nymphs and adult hosts; Tachinids have been found in nymphs of all instars from the second onwards and in adults, from early June to late August.

Brief notes are given on characters that make it possible to identify a number of the parasites in the larval stage, but the immature stages of these parasites are to be the subject of another paper.

In the laboratory at 75°F., *S. atlanis*, *S. hunteri*, *S. reversa* and *S. aculeata* had a pre-larviposition period of about 6 days, and individuals without a diapause completed the larval and pupal stages in about 5–14 and 14–16 days. *S. aculeata* and *S. reversa*, however, often enter diapause in the mature larval stage and require a period of hibernation before their development can be continued.

PICKETT (A. D.), NEARY (M. E.) & MACLEOD (D.). **The Mirid, *Calocoris norvegicus* Gmelin, a Strawberry Pest in Nova Scotia.**—*Sci. Agric.* **24** no. 6 pp. 299–303, 2 refs. Ottawa, 1944.

Failure to develop or malformation in the fruits of apparently healthy strawberry plants, observed for several years in Nova Scotia, was shown by field observations in 1939–42, confirmed in 1943 by greenhouse studies made by one of the authors (MacLeod) and by a survey of the strawberry producing areas in the Province, to be caused by the feeding of nymphs of *Calocoris norvegicus*, Gmel. It is possible that other factors, including incomplete pollination, adverse weather, infestation by *Lygus oblineatus*, Say, or virus disease may at times be responsible, but all the principal producing areas proved to be infested by *C. norvegicus* and typically malformed fruits were found in all cases in proportion to its abundance.

This Capsid has previously been recorded from grasses in Nova Scotia, Quebec and the United States; the numerous cultivated plants attacked by it in Europe and the weeds selected for oviposition in Eire [*R.A.E.*, A **10** 590] are cited from abstracts in this *Review*, and a list is given of 19 species of wild and cultivated plants on which adults were found in Nova Scotia. Further studies are necessary to determine the plants on which oviposition occurs there; eggs have been found in the stems of sheep sorrel (*Rumex acetosella*), the preferred food-plant, on which nymphs are common, and adults oviposited in the stems of strawberry in cages and presumably do so in the field. Nymphs were first found on strawberry when the earliest fruits on early varieties were half-grown, and less injury was observed on these than on later fruits. Adults appeared during a period of about two weeks when the fruit was ripe and dispersed immediately to other food-plants. Field observations suggest that the eggs overwinter and that there is one generation in a year.

Methods of control still require investigation. Burning the mulch in spring (as opposed to removing it from the plants and placing it between the plant rows) is not considered good horticultural practice, but some years' experience in the field had shown that it improves the crop, presumably by destroying the eggs in the stems of the strawberry plants and weeds. The deep mulch of

oat-straw was burnt over part of an experimental field in April 1942 and the nymphs were much less numerous than in the unburnt part throughout the growing season. There were none in the early part of the season, but some appeared later, having presumably migrated from *R. acetosella* and other neighbouring food-plants as well as from the unburnt area. The percentages of uninjured fruits of a susceptible variety were 48·1 in the burnt area and 0·5 in the unburnt one, while the percentages of injured fruits in which the injury was slight, moderate and severe were 32, 29, and 39 in the former and 2, 2 and 96 in the latter. In experiments with various types of mulch, there was no significant difference in the degree of infestation, but since infestations were reduced in some cases in plantations left without a mulch during the winter, it is possible that insects or eggs may be imported in mulch or may be protected by the shelter that it provides.

In the laboratory high kills were obtained in extensive tests with sprays of 100 gals. water and 4 lb. soap with 1 pint nicotine sulphate, 1 pint anabasine sulphate, 3 lb. pyrethrum or 1 pint commercial extract containing extractives equivalent to 20 lb. pyrethrum flowers (0·9 per cent. pyrethrins) per U.S. gal. The addition of 4 lb. lime to the nicotine-sulphate spray reduced its effectiveness, and commercial wetting and penetrating agents used with nicotine sulphate and pyrethrum proved inferior to soap. Nicotine sulphate with strongly alkaline soap appeared to be the best spray in the laboratory and showed some promise in the field, where it must be applied heavily by highly efficient power sprayers under optimum conditions, as the nymphs are very active and at the least disturbance drop to the ground to shelter in litter. Two or more applications may be necessary, and spraying should be started early, since the initial injury is done to the blooms or small fruits. Pyrethrum and nicotine-sulphate dusts applied with a power-driven cranberry-type duster under a 30 ft. trailer gave unsatisfactory results.

HAYWARD (K. J.). **Hespéridos americanos cuyas larvas perjudican la caña de azúcar.** [American Hesperiids that damage Sugar-cane in the larval Stage.]—*Rev. industr. agríc. Tucumán* **33** no. 1–3 pp. 11–18, 22 refs. Tucumán, 1943.

Notes are given on the synonymy and distribution of 18 species of Hesperiids that attack sugar-cane in America. Of these *Hylephila phylaeus*, Dru., *Lerodea eufala*, Edw., *L. tripuncta*, H.-S., *Perichares philetes*, Gmel. (*phocion*, F.), *Panoquina* (*Calpodes*) *nero*, F., *P.* (*C.*) *ocola*, Edw., *P.* (*C.*) *sylvicola*, H.-S., and another species, probably *P. nyctelius*, Latr., occur in Argentina, where, however, they attack various grasses and have been found on sugar-cane only in isolated instances. They are therefore not considered to be of economic importance.

ANDREWARTHA (H. G.). **The Influence of Temperature on the Elimination of Diapause from the Eggs of the Race of *Austroicetes cruciata* Sauss. (Acrididae) occurring in Western Australia.**—*Aust. J. exp. Biol. med. Sci.* **22** pt. 1 pp. 17–20, 1 fig., 7 refs. Adelaide, 1944.

The area in which *Austroicetes cruciata*, Sauss., occurs in Western Australia [*R.A.E.*, A **29** 169] is quite isolated from the area of its occurrence in eastern Australia [**26** 584 ; **28** 332], and specimens from the two regions have certain morphological differences suggesting two distinct races. The annual life-history of the western race is the same as described for the eastern race [**31** 349], except with regard to the temperature required for the elimination of the diapause. In the case of the eggs of the western race, exposure to 13·3°C. [55·94°F.] was more effective for eliminating diapause than exposure to 10°C. [50°F.] or 6·5°C. [43·7°F.], whereas 10°C. had proved the most favourable

temperature of the three with the eastern race. The fact that the temperature most favourable for elimination of diapause is higher in the western race agrees with the higher winter temperatures prevailing in Western Australia.

HELSON (G. A. H.) & NORRIS (D. O.). **Transmission of Potato Virus Diseases. 3. Susceptibility of Cruciferae to Potato Leaf Roll Virus.**—*J. Coun. sci. industr. Res. Aust.* **16** no. 4 pp. 261–262, 2 refs. Melbourne, 1943.

An attempt was made in Canberra in 1942 to confirm by means of greenhouse experiments the findings of Salaman & Wortley, who reported the successful transmission of potato leaf-roll [*Corium solani* of Holmes] through turnip and brussels sprouts to potato by grafting and by *Myzus persicae*, Sulz., respectively [*R.A.E.*, A **28** 324]. Batches of 15–20 Aphids from colonies of *M. persicae* on diseased potato plants were allowed to feed for a week on rape, brussels sprouts, radish, broccoli, kale, swedes, several varieties of turnip and cabbage and peach, after which they were destroyed. Two days later, uninfected Aphids were allowed to feed on the plants for 1–2 weeks, after which they were transferred to healthy potato plants. No symptoms of leaf-roll developed in these plants or in those produced the next year from their tubers, and no symptoms were observed on the cruciferous plants or peach. Similar negative results were obtained when peach seedlings and plants of the various crucifers (except the turnips) were first grafted with infected potato and after some weeks were grafted on to healthy potato plants.

HANSON (H. S.). **Observations on the Life Cycle of the Pine Shoot Beetles.**—*Scot. For. J.* **54** pt. 2 pp. 64–79, 17 refs. Edinburgh, 1940. [Recd. 1944.]

It has commonly been supposed that *Myelophilus piniperda*, L., has two generations in the year in Great Britain, but from examination of large amounts of material in almost all parts of the country, the author concludes that there is never more than one. The life-cycle is very irregular, owing mainly to variations in the climatic conditions, the density of the initial population and the quantity and quality of available breeding material, and these factors may result in four slightly different types of life-cycle in the same area in any one year. Where there is a large initial beetle population and a relatively limited amount of suitable breeding material, thick-barked material becomes congested ; after a relatively short egg-gallery is completed, the parent beetles leave it, feed in the pith of the shoots of growing pines in order to recuperate their reproductive organs and then form a second egg-gallery, using stems with thinner bark if necessary. The young beetles from the first gallery emerge from the end of June to the end of July and feed in the shoots of growing pines throughout the summer and autumn. Those from the second gallery emerge later in the summer and also feed in the pine shoots, and both broods hibernate as adults. Where the initial population is not excessive, relative to the available breeding material, an egg-gallery of great length is formed and many eggs are laid ; if the material is fresh, the female feeds on the cambium as the egg-gallery is being extended and so does not need to leave the gallery. The young beetles begin to emerge towards the end of June and continue to emerge throughout the summer ; they feed in the shoots of growing pines in the summer and autumn and hibernate. When abnormal quantities of breeding material are available throughout the year, as they are during periods of continued heavy felling and thinning, when extensive windfalls occur and after widespread fire, if the timber is left lying in the forest with the bark intact, the parents are able to feed as they work, very long egg-galleries are formed and a large number of eggs are laid by each female. If the weather is warm and favourable, the vitality of the parent

beetles is maintained at a high level, and when they leave the first egg-gallery, late in the summer, some of them form an additional gallery. The young beetles emerge from the first egg-galleries from the latter part of June until the end of the summer, feed in the shoots of growing pines until late autumn and then hibernate. The second brood continues to develop during the late summer and autumn and overwinters in the pupal chambers as full-grown larvae, pupae or immature adults. Mortality is very high in this late second brood ; the young adults emerge in spring and, after feeding in the shoots of growing pines, mature and begin breeding in late spring or early summer, giving rise to a brood that coincides with the second one produced by individuals that hibernated in the adult stage.

The damage caused by outbreaks of the beetles and the prevention and control of these are discussed [*cf.* next abstract, and *R.A.E.*, A **25** 643–645 ; **28** 408–410].

Hanson (H. S.). **The Control of Bark Beetles and Weevils in coniferous Forests in Britain.**—*Scot. For. J.* **57** repr. 29 pp. Edinburgh, 1943.

The author discusses the factors that effect ecological control of bark-beetles and weevils in coniferous forests [*cf.* *R.A.E.*, A **28** 410], including attack by parasitic and predacious insects, lists of which are given [*cf.* **25** 644], and the overcrowding of breeding material, and those that favour outbreaks, such as unsatisfactory drainage conditions, windfalls, damage due to snow or to fire and ill-timed thinning [*cf.* **28** 409]. Large-scale felling, resulting in constantly increasing quantities of suitable breeding material, is a serious source of damage to surrounding young crops, and, in areas where natural regeneration is being carried out, neglect to control bark-beetles may result in severe injury to the crowns of the seedling trees ; moreover, when the beetles are allowed to breed in the bark of felled timber, the sapwood is often stained blue and the timber is reduced in quality. Much damage may be caused to larch by *Tetropium gabrieli*, Weise, if the larvae are allowed to form pupal chambers in the timber, and similar injury to spruce by *Molorchus minor*, L., in the districts in which the latter is numerous ; *Tetropium* also attacks spruce at times. Felling areas can be prevented from becoming sources of infestation by these Cerambycids or species of *Myelophilus* by correct co-ordination between felling, extraction and conversion. Felling should be arranged so that the timber can be removed in the order in which it is cut and all converted within six weeks, so that the insect broods will be destroyed before they can complete their development. Since both species of *Myelophilus* [*piniperda*, L., and *minor*, Htg.] and also *Pissodes pini*, L., and *P. notatus*, F., though normally breeding in the bark of standing trees, may utilise that of stumps, and *Hylobius abietis*, L., and *Hylastes ater*, Payk., normally do so, trees should be cut off as near the ground as possible.

Hylobius abietis and *Hylastes ater* are both extremely important forest pests when conditions are favourable for their excessive increase, particularly when conifers are felled and the ground replanted. Adults of *Hylobius* normally feed on the bark of the upper trunk and branches and twigs of growing trees, preferring the thin green bark of pine and other conifers but also attacking the bark of hardwoods when necessary, and adults of *Hylastes* feed and both species breed in the bark of the roots of conifers or of material lying in contact with the soil. They prefer pines, but will breed in larch and spruce and also in other conifers, though these are less attractive. They are normally controlled by natural enemies and by competition for the limited supply of suitable breeding material. The eggs of *Hylobius* are laid singly. Larvae from eggs laid in the spring and early summer are generally full-grown by late autumn, but do not usually pupate until the following summer, and the weevils normally begin to emerge about the middle of July. Larvae from eggs laid in the late

summer and early autumn pupate during late summer in the following year; the weevils emerge during August, September or October, or remain in the pupal chambers until the following spring. Under exceptionally favourable conditions in south-eastern England, larvae hatched and transformed in the same season and the adults emerged next spring, and at very high altitudes in North Wales and the north of Scotland, larvae from eggs laid during the summer of 1941 pupated and transformed late in 1942, and the weevils emerged in the spring of 1943. The pupal chambers are in the bark if it is very thick, between the bark and the wood if it is of medium thickness and in the wood if it is very thin. The weevils emerge earlier from pupal chambers in the thick bark near the surface than from those in the root wood, which are often several feet from the stump and a considerable distance below the surface, and earlier from stumps and roots in light sandy soil than from those in heavy soils. The eggs of *Hylastes* are laid in egg-galleries formed between the wood and bark or partly excavated in the surface of the wood if the bark is thin, mainly in spring, though galleries containing eggs and larvae in all stages of development may be found throughout the year. Development from egg to adult is generally completed within three months, but may take much longer under less favourable conditions. The young beetles usually continue to feed in the bark if this is not completely exhausted, or move to other parts of the root system where the bark is still fresh. After a period of feeding, they pair and reproduce until the whole of the bark is exhausted or unsuitable. This process may extend over 3–4 years, after which beetles come to the surface and search for food. If the area has been replanted, they feed on the bark of the roots and trunk below ground level of the young plants, sometimes burrowing up inside the bark for several inches above ground level.

The damage caused by *Hylobius*, which sometimes completely ringbarks the young plants and kills them, is conspicuous and usually detected at an early stage, but that due to *Hylastes*, which is the most destructive insect in young coniferous crops in Britain at the present time, is often not noticed until many of the young trees have been killed. Trees with established roots will generally survive severe attacks of *Hylobius*, but those attacked by *Hylastes* are always killed.

In Great Britain, the larvae and pupae of *Hylobius* are attacked by the Ichneumonid, *Ephialtes tuberculatus*, Geoffr., a solitary parasite, and by *Bracon* (*Microbracon*) *hylobii*, Ratz., which is gregarious, the female usually laying 10–20 eggs on a single host larva. This Braconid is extremely active and often attacks a large proportion of the host population. Larvae of *Thanasimus formicarius*, L., and *Pityophagus ferrugineus*, L., are probably the most important predators of *Hylobius*. *Hylastes* larvae are seldom parasitised, but the eggs and larvae are very heavily attacked by the larvae of predators, particularly by Nitidulids. A number of other beetles compete with *Hylastes* and *Hylobius* for food. Certain Longicorns oviposit in the bark of the stumps and round the base of the large roots, and there the larvae develop very rapidly, destroying wide bands of cambium and bast. They often isolate larvae of *Hylobius* and *Hylastes* and deprive them of food, and cause the rapid desiccation of the bark. In the south the emergence holes of *Asemum striatum*, L., which feeds in the wood for a time before pupating and emerges through the surface of the stump, allow water to penetrate into the timber and cause the more rapid disintegration of the stumps and roots. *Rhagium inquisitor*, L. (*indagator*, F.) and *Acanthocinus aedilis*, L., which appears to be increasing, are fairly common in pine areas in the north, and *Criocephalus rusticus*, L., is common in pine forests in some parts of Britain; all these Longicorns breed in the bark of pine and compete with the larvae of *Hylobius* and *Hylastes* in the stumps, and several species of bark-beetles, including *Myelophilus* and *Hylurgops*, accelerate the destruction of the available breeding material.

Mechanical and chemical measures of controlling *Hylobius* [*cf.* **30** 28] are too expensive, and trapping adults before felling is ineffective, as it relieves congestion and enables a large proportion of the larvae to complete their development; it also prolongs the period during which the stumps and roots remain suitable for breeding purposes. It is impossible to trap all the weevils in extensive coniferous forests before felling takes place in any particular area, and if the weevils in a given area are trapped before felling, others are attracted from surrounding stands. Where large-scale felling is taking place, it should be carried out in one general direction, starting if possible at the point nearest to any existing young plantations; the population of *Hylobius* and *Hylastes* follows the general direction of the fellings, and the fresh lop and top provides the insects with plenty of food and keeps them from invading the young plantations. As the felling areas increase, populations of these and other insects increase and rapidly exhaust the stumps and roots, and parasites and predators also increase, resulting in a very high rate of mortality.

Trapping should not be carried out until a year after the last felling in any particular block, when it should be concentrated in the last felling area to destroy the remnants of the parent weevil population and the young weevils as they emerge from the stumps. By this time, the area in which the first felling took place should be clear of injurious insects. Where isolated blocks of conifers have been felled and no felling is likely in adjoining areas, weevils attracted to the area should be allowed to infest the stumps, and traps should be prepared when adults begin to appear in the pupal chambers, in order to catch them when they emerge. The most generally satisfactory trap is prepared by making a pit 30 ins. long, 18 ins. wide and not more than 3 ins. deep, embedding a freshly cut straight pine billet 2 ft. long and 3–3½ ins. in diameter, with smooth, fairly thick bark, horizontally to rather more than half its depth along each side close to the wall of the pit, and filling the space between and partly covering the billets with a fairly large bundle of fresh pine branches about 2 ft. long, arranged to form a dense mat about 15 ins. wide and 3–4 ins. thick. The branches should be tied firmly together about 6 ins. from the ends so that the bundles can be lifted easily. If bark of any species of conifer is available, two sheets, with the cambium sides together, should be put under the bundle of branches, which should be weighted with a stone or piece of thick turf. The traps should be spaced about 22 yards apart throughout the felled area. The weevils should be collected by lifting the bundles and shaking them over a sheet of canvas and by brushing the insects off the sheets of bark by hand, every second or third day during the first week or two and every day when emergence becomes fairly general. The bark and branches should then be put back; the bundles of branches should be renewed every three weeks. When the billets, which are primarily intended to trap *Hylastes*, have been in position for about six weeks, a few should be examined from time to time, and when beetles are found on them, they should be burnt and replaced with fresh ones. If felling takes place during the autumn, winter and early spring, *Hylobius* will oviposit in the stumps during the late spring, summer and autumn, and emergence of the first brood will probably begin about the middle of the next July. The traps should remain in position throughout the autumn, and a few should be put down at about the beginning of the following April to catch overwintered weevils; they should be examined every second or third day, and when weevils are found in them, the number of traps should be increased. By about the end of May, most of any untrapped weevils will have gone below ground to oviposit, and the billets should be burnt, any weevils found under them being destroyed. Further trapping will not be necessary until about the middle of July, when the next brood will begin to emerge. Intensive trapping should be carried out again during the autumn, and hibernating weevils should be collected again the following spring, by which time the stumps and roots

will probably be exhausted. If *Hylastes* beetles and larvae are still present, special traps should be prepared by digging sloping pits, about 18 ins. long by a spade in width and sloping from ground level to about 9 ins. in depth, and burying two fresh pine billets about 2 ft. long by 3–3½ ins. in diameter, with a narrow strip of bark cut off along each side, in each pit, with about 3 ins. projecting at the shallow end. The pits should be spaced 11–22 yards apart throughout the area. The billets should be examined from time to time after they have been in position for at least six weeks. When heavily infested, they should be burned and replaced with fresh ones until the ground is found to be clear of *Hylastes*. Where the stumps are 9–10 ins. in diameter or less, trapping during the second season may not be required, but where they are very large, it will almost certainly be necessary. Where isolated felling areas adjoin existing young plantations, the traps should be put closer together at the side of the felling area nearest to the young trees, but not within the young plantations.

Running fowls or ducks in young plantations during autumn and spring helps to protect them; pheasants in sheltered districts and curlews in moorland districts also give some control of the weevils. Under existing conditions, it is not safe to replant felled coniferous areas with fresh conifers until at least three years after felling, and a longer period may be necessary where later fellings have taken place in adjoining areas, unless special protective measures are taken. Where soil conditions are suitable for them, replanting with hardwoods should be considered, as they are less liable to damage by *Hylobius* and are immune from *Hylastes*.

Krishnamurti (B.) & Seshagiri Rao (D.). **A preliminary Note on the Breeding of a beneficial ectophagous larval Parasite (Braconidae) on a Laboratory Host.**—*Curr. Sci.* **13** no. 3 pp. 81–82. Bangalore, 1944.

Krishnamurti (B.) & Appanna (M.). *Microbracon brevicornis*, **W. in the Biological Control of the Lab-lab Podborer.**—*T.c.* no. 5 p. 135.

The authors of the first paper state that the natural host of *Bracon* (*Microbracon*) *hebetor*, Say,* in Bangalore (Mysore) is *Adisura atkinsoni*, Moore, which infests the pods of lab-lab [*Dolichos lablab*], and give brief records of its successful rearing in the laboratory on larvae of *Corcyra cephalonica*, Staint., which are pests of stored rice, sorghum and flour. So far as they are aware, this is the first occasion on which *B. hebetor* has been reared in India on a host other than its natural one.

The second paper comprises a brief account of experiments in which *B.* (*M.*) *brevicornis*, Wesm.,* a natural parasite of *C. cephalonica* in Bangalore, successfully parasitised larvae of *A. atkinsoni* in lab-lab pods, both in the laboratory and in field plots in which it was released. *B. hebetor* was also reared from larvae of *Adisura* collected in the field plots.

Negi (P. S.), Venkatraman (T. V.) & Chatterjee (K. C.). **The Mass-breeding of the Braconid,** *Microbracon hebetor* **Say, in India.**—*Curr. Sci.* **13** no. 5 p. 136, 3 refs. Bangalore, 1944.

Referring to the first of the papers noticed in the preceding abstract, the authors point out that, since 1934, *Bracon* (*Microbracon*) *hebetor*, Say, has been bred in large numbers on various hosts in the laboratory at Namkum (Bihar) for use against larvae of *Holcocera pulverea*, Meyr., and *Eublemma amabilis*,

* It may be of interest to note that these records reverse the usual host relations of *B. hebetor* and *B. brevicornis*; they have been confused in the literature, but it is commonly considered that *B. hebetor* is chiefly a parasite of Lepidoptera in stored products, while *B. brevicornis* is a parasite of Lepidoptera in the field. *B. hebetor* was recorded as a parasite of *C. cephalonica* in southern India in 1934 [*R.A.E.*, A **22** 488].—*Ed.*

Moore, which are predacious on the lac insect [*Laccifer lacca*, Kerr] [*cf. R.A.E.*, A, **24** 483; **29** 264, etc.]. In 1942–43, it was successfully reared on *H. pulverea*, *Ephestia cautella*, Wlk., *Platyedra gossypiella*, Saund., and *Corcyra cephalonica*, Staint. Its natural hosts include *E. cautella* on *Bassia latifolia* in Bihar [*cf.* **30** 381], *Antigastra catalaunalis*, Dup., and *Laphygma* sp. in Delhi [**28** 512] and *C. cephalonica* [**22** 488] and *Adisura atkinsoni*, Moore, in southern India.

RAHMAN (K. A.). **Prevention of Damage to stored Potatoes by the Potato Tuber Moth.**—*Curr. Sci.* **13** no. 5 pp. 133–134. Bangalore, 1944.

Tests were carried out in the Punjab to determine the best way of protecting stored potatoes from *Gnorimoschema* (*Phthorimaea*) *operculella*, Zell. Heaps of potatoes covered with a 1-inch layer of sand, chaff or various leaves, and control heaps left uncovered, were kept with infested potatoes in a room. In potatoes stored on two racks and on the floor, infestation in the covered heaps varied from 5·3 to 1·8, 7·3 to 0·3 and 29·1 to 3·1 per cent., respectively, as compared with 50·6, 56·1 and 73·1 per cent. in the uncovered ones.

GADD (C. H.). **An unusual Correlation between Insect Damage and Crop harvested.**—*Ann. appl. Biol.* **31** no. 1 pp. 47–51, 9 refs. London, 1944.

Xyleborus fornicatus fornicatior, Eggers, has long been regarded as a major pest of tea in certain districts of Ceylon, but its effect on crop yields is difficult to estimate; the infested stems appear to grow normally and contribute to the crop, but may break during high winds or plucking. Branches containing galleries from which the brood has emerged and the entrances to which have become plugged with callus tissue are thought to be less liable to break than those in which the entrances to the galleries are still open; this is attributed to extra strength given by the greater amount of new wood between the gallery and the cambium in these twigs, which must be older than those in which the galleries are still open, since the females oviposit mainly in branches about ½ in. in diameter [*cf. R.A.E.*, A **30** 232].

Earlier work [**13** 357; **15** 210] indicated that the application of manures increased the percentage of healed galleries, but the damage caused by the beetles was not measured. The estimation of the number of beetles present in a given area is difficult, since counting the number of galleries in the living bushes is liable to considerable error, particularly with regard to the healed galleries, and the method of pruning the bushes and examining the prunings cannot be used where accurate records of yield are required, as it involves pruning the bushes at unusual times. The author considers that the number of broken branches in each plot represents a random sample and provides the best measure of damage by the beetles.

This method was adopted in an experiment designed by T. Eden to determine the effect of various manurial treatments on yield in plots covering an area of about 3 acres that were pruned in September 1940 and from which plucking began on 13th December 1940. Broken branches were first collected on 31st January 1942, when 2,689 were obtained over the whole area, and collections were continued weekly after each plucking. Detailed examinations were not made immediately, except in the case of branches collected on 4th September and 2nd and 30th October 1942, the results from which were amalgamated and taken to represent conditions at the end of the second year from pruning. These results, including the number of broken branches, the number of galleries, healed galleries and beetles present in 100 broken branches, the percentage of healed galleries, and the mean number of beetles in occupied galleries for plots receiving each of the various manurial treatments are given in a table. A total

of 59,240 branches were collected from the whole area during the two years, and the weight per acre of these branches while fresh is estimated as 1,044 lb.; if the weight of normal pruning from uninfested bushes is 6,000 lb. per acre, this represents a loss of approximately 17·4 per cent. of the crop-bearing branches, which might reduce the crop by as much as 8 per cent. Statistical analysis showed that in the main the manurial treatments tested had no significant effect on yield, or the number of breakages or of galleries. This result was unexpected, since tea in general responds well to such treatment, but the correlation between yield and the number of broken branches was found to be high, and an analysis of co-variance indicated that the number of breakages varied directly with the fertility of the plots as measured by yield. It is therefore concluded that both yield and insect damage was increased by the manurial treatments and that the observed increase in yield resulting from the treatments is consequently less than that that would occur in uninfested plots. The results obtained on the three occasions on which detailed examinations were made are to be regarded as typical of the whole period, since the correlation between the number of breakages recorded on them and the total number of breakages was significantly high.

In a discussion of the ways in which manuring may lead to increased damage, it is stated that analysis of the data gives no definite indication that it resulted in an increase in the number of galleries present; the existence of a change in the structure or composition of the branches cannot be directly demonstrated from the observations described. It has been suggested that manuring assists the closing of galleries, thus decreasing the number of breakages, by inducing rapid growth. Analysis of the data obtained at the three examinations indicates that there were fewer healed galleries than would be expected if they and the open ones were equally liable to cause damage. The number of healed galleries was found to increase with the total number of galleries, however, and the manuring therefore had no beneficial effect on healing. It is concluded that manurial treatment tends to increase damage, possibly owing to an increase in the number of galleries formed.

The mean number of beetles present per gallery ranged from 1·88 to 2·97; as an adult female was present in each, the number of immature stages was small, indicating a decrease in the rate of breeding [*cf.* **30** 509]. A similar trend was suggested by the mean number of broken branches taken after each plucking, which was 1,205 in February 1942, 2,450 in June, 1,162 in September, and 268 in February 1943. It is therefore possible that lower infestation in the third year from pruning may permit manuring to produce a significant increase in yield.

Salt (G.) & Hollick (F. S. J.). **Studies of Wireworm Populations. I. A Census of Wireworms in Pasture.**—*Ann. appl. Biol.* **31** no. 1 pp. 52–64, 7 figs., 15 refs. London, 1944.

The majority of studies on wireworm populations deal only with the larger larvae, which are the most injurious to crops, but a knowledge of complete populations is necessary to obtain ultimate control, since treatments ineffective against the older larvae may destroy the younger ones, and a full assessment of climatic and edaphic factors must include their effect on all stages. The authors describe in detail a method for separating complete populations from turf. The soil is broken up into particles too small to retain the larvae by freezing it in enough water to cover it at a temperature of −12°C. [10·4°F.] for 48 hours or more, which will pulverise even stiff clay soils, and washed through two sieves, with meshes 7 and 2·5 mm. in diameter, into a reservoir. The vegetable débris in the coarse sieve is discarded after washing with a strong jet of water to dislodge any larvae present, and that in the other is washed well and then added

to the reservoir, which then contains the whole sample, except the coarse vegetation, in a finely-divided state. The contents of the reservoir are placed in a vessel containing a sieve with a mesh 0·2 mm. in diameter, which retains all stages of wireworms, including eggs, and very fine silt is washed through. The sides below the sieve are funnel-shaped and the narrow end is closed by a rubber bung carrying a tube that supplies a jet of compressed air. A solution of magnesium sulphate with a specific gravity of about 1·2 is poured into the vessel and air bubbled through it, which frees wireworms and other organic material that will float in a solution of this specific gravity [*cf. R.A.E.*, A **25** 109]. More solution is then added until the floating matter passes over a lip into a lamp-glass, the lower end of which is covered by bolting silk. This process is performed twice. The wireworms are separated from the other organic matter by violently shaking the material from the bolting silk in a wide-necked flask containing benzene and a little water. Since insect cuticle is wetted by benzene, whereas most plant material is not, the insects collect at the interface of the water and benzene, the vegetable matter remaining in the water. As much of the vegetable matter as possible is thrown down by decreasing the pressure and restoring it again, and the benzene and floating material is then made to overflow into a large beaker by means of a slow jet of water introduced below the interface. The larvae are easily collected from the benzene and water interface in this vessel by means of a brush or pair of forceps. Collections made by this method are thought to include over 99 per cent. of the wireworms present in the sample, and a standard sample of difficult clay soil can be examined by one person in 1½ hours. All stages are recovered in excellent condition, except that some pupae may be broken by the jet of water, but the separate pieces collect on the benzene interface and are so few that they can easily be associated. This method indicated wireworm populations three times as large as those shown for the same pastures by that employed by advisory entomologists, but the latter is sufficiently accurate to give correlation with crop yields [**30** 270]. By the new method, populations ranging up to 10 million per acre were found in the top 12 in. layer of soil.

Preliminary observations were made on the wireworms in two fields near Cambridge, in both of which *Agriotes sputator*, L., comprised over 95 per cent. of the population. One of these was a permanent pasture on shallow clay loam overlying heavy clay that had been only lightly grazed in recent years, and the other had been under grass for 10 years and was on very heavy clay. Details are given of the ways in which the soil samples were taken ; some were obtained each month for over a year from each field. Of 6,507 larvae from the permanent pasture, 59 per cent. ranged in length from 2 to 6 mm., 26 per cent. from 6·1 to 10 mm., 9 per cent. from 10·1 to 14 mm., and 6 per cent. from 14·1 to 24 mm. ; the corresponding percentages for the other field were 52, 23, 12 and 13. As the numbers of larvae of any one size within these groups did not decrease steadily with their size, but showed more or less well-defined peaks, it is possible that the size-groups correspond with age-groups (larvae in their first, second, third and fourth years). Histograms drawn from the data from the permanent pasture show marked constrictions about lengths of 4–5 mm. and 8 mm. Other histograms drawn for the total populations from this pasture for each quarter of the year exhibit the same form, which is not therefore due to seasonal bias. The populations of five other pastures in Cambridgeshire, two in Kent, one near Manchester and one in Norfolk were examined and were all of similar composition, but that from an uncultivated and ungrazed field in Norfolk situated on black fen soil and sparsely covered with small weeds, mostly of the rosette type, was not. Few observations were made on the other stages. Adults are scarce from mid-June to mid-August, which corresponds approximately to the period during which eggs and pupae are present. Eggs were found in sufficient numbers to provide the number of small larvae present in succeeding

months, and the adults recovered from the two pastures represented only 2 per cent. of the total number of larvae, thus allowing for considerable larval mortality.

BATT (R. F.), MARTIN (H.) & WAIN (R. L.). **The Use of toxic Polynitro Derivatives in Pest Control. II. The Estimation of Dinitro-o-cresol in Winter Washes.**—*Ann. appl. Biol.* **31** no. 1 pp. 64–68, 5 refs. London, 1944.

The authors describe two methods for the extraction by means of an alkali and an acid, respectively, of 3 : 5 dinitro-o-cresol from stock emulsions in petroleum oil for estimation by gravimetric and volumetric methods [*R.A.E.*, A **31** 143] ; the results obtained by both were sufficiently accurate for routine work. Alkaline extraction failed when sulphite lye was the emulsifier, owing to the action of reducing sugars present in the lye. The method of acid extraction, which effectively removes these sugars, was therefore devised for use with any stock emulsions responding to tests for reducing substances, which are given. Sulphite lye may also cause contamination of the extracted cresol by sulphurous and other acids, and although sulphur dioxide was shown to have no reducing action on dinitro-o-cresol, the presence of these acids would affect the volumetric estimation, which depends on the acidic nature of the cresol. It was shown, however, that the small amount of sulphur dioxide liberated during the analysis of a stock emulsion compounded with sulphite lye is effectively removed during the acid method of extraction. Acid contamination does not affect the results obtained by the gravimetric method of estimation.

FINNEY (D. J.). **The Application of the Probit Method to Toxicity Test Data adjusted for Mortality in the Controls.**—*Ann. appl. Biol.* **31** no. 1 pp. 68–74, 6 refs. London, 1944.

The author points out that allowance must frequently be made for a natural mortality rate in assessing the proportion of insects killed as a result of the application of poison, and, in the case of eggs, for the proportion unfertilised in determining the proportion prevented from hatching. In toxicity tests, it is usual to estimate the natural death rate from that of an untreated batch of insects. This gives a result very close to the maximum likelihood solution for the normal curve relating percentage kill to log concentration if the natural mortality is low, provided that a reasonably large control batch is used, but the larger the natural mortality, the more important are the effects of modifications arising from the fact that both the effective number of test organisms exposed to the poison and the weighting coefficients used in the probit analysis are affected by the natural mortality and that the estimate used is subject to sampling errors. For natural mortalities up to 20 per cent., a satisfactory approximation may be obtained by a simple alteration in the weighting coefficients, particularly if 2–3 times as many test organisms are used as controls as for any dosage of poison ; the modified weighting coefficients are tabulated for values of natural mortality from zero to 20 per cent. The maximum likelihood solution requires the estimation of the natural mortality from the whole of the data ; an example of the more complex calculations required, based on a trial of the toxicity of different concentrations of pyrethrins to eggs of *Ephestia kuehniella*, Zell., is discussed in detail.

OXLEY (T. A.) & HOWE (R. W.). **Factors influencing the Course of an Insect Infestation in bulk Wheat.**—*Ann. appl. Biol.* **31** no. 1 pp. 76–80, 2 figs., 4 refs. London, 1944.

Features of the environment provided by wheat stored in bulk in Great Britain that are of significance in relation to its insect pests are that temperatures

low enough to kill them are frequent and temperatures above the optima for them are rare ; that the thermal conductivity of grain is low, varying between 0·00036 and 0·00040 c.g.s. units, and the bulks of wheat are large, so that the central parts are often unaffected by seasonal variations in temperature ; and that although the relative humidity in bulks of English wheat may be as high as 80–85 per cent., most of the wheat stored for long periods is imported and the relative humidity produced in bulks of it is only about 60 per cent., which is low for most insects.

In a consideration of the importance of the production of heat and water, the redistribution of water within the wheat bulk and the modification of the composition of the intergranular air owing to the presence of insects, it is stated that a carbon dioxide figure [*R.A.E.*, A **32** 243] of 1 per cent. represents a light infestation and one of 5–10 per cent. a heavy one, but that figures up to 1,000 per cent. may occur for short periods in small quantities of grain and are common in insect cultures. From the known heats of combustion of carbohydrate, protein and fat, it is estimated that heat production in the presence of an infestation equivalent to a carbon-dioxide figure of 1 per cent. is between $1{\cdot}78 \times 10^{-7}$ and $2{\cdot}33 \times 10^{-7}$ calories per sec. per cc. infested grain, and it is further calculated that a significant rise in temperature is not produced unless a bulk of 6 metres cube is infested throughout to this extent, although an infestation equivalent to a carbon-dioxide figure of 10–20 per cent. will produce a considerable rise in a volume only 1 metre cube. The increase in the rate of heat-production resulting from a rise in temperature can proceed only to a maximum temperature determined by the temperature tolerance of the insects. This has been observed to be as high as 38–42°C. [100·4–107·6°F.], although the maximum temperature for the development of *Calandra* is about 35°C. [95°F.] and the maximum for oviposition about 32°C. [89·6°F.]. The vapour pressure of water in grain rises with temperature, but owing to the slow rate of diffusion of air in grain, the resulting transference of water is important only where the temperature gradients are very steep, as occurs locally where temperatures are high near the surface or near metal girders. The increased humidity round infested grain is not thought to be due to the water produced by the oxidation of hydrogen in the food of the insect (metabolic water), since it is estimated that the metabolic water resulting from an infestation equivalent to a carbon dioxide figure of 1 per cent. could raise the water content only by approximately 4×10^{-4} per cent. per day. Infestations dense enough to raise the water content appreciably by this means can exist only in small patches or in cultures, since lethal temperatures are quickly reached in large bulks. The carbon dioxide concentration in the intergranular air of infested grain has been shown normally to be considerably lower than 1 per cent. by volume, and there is no evidence that such concentrations affect insect metabolism or reproduction. The movement of gases within the bulk is normally by convection, which, however, can only occur where heating is sharply localised. In bulks in which heating is uniform, concentrations of carbon dioxide of 4–5 per cent. or more may occur, even where the bulk is shallow, but heating generally begins in patches, and the process is rarely allowed to reach the later stage at which it becomes uniform. In narrow storage containers, there is rarely sufficient room for upward and downward convection currents to develop, and gaseous exchange takes place by the slower method of diffusion. Accumulations of carbon dioxide may occur in deep silos, which are not as a rule air-tight, but these are not generally maintained, since the carbon dioxide collects near the bottom and passes out through openings there.

The probable courses of development of infestations in bulk wheat and at its surface under conditions in Great Britain are described. Except in very large masses of grain, the onset of cold weather is likely to interrupt the development of the first generation in bulk wheat and winter temperatures to prevent the

survival of any stage of *C. granaria*, L., and *C. oryzae*, L., except adults of the former. These, however, can oviposit in early summer and the chances of survival beyond the first generation are then very high. The typical patchy development of infestation is probably due chiefly to differences in the original density or date of oviposition or to local conditions of humidity or temperature, but it can also be caused by mixing grain with different intensities of infestation. When by these means temperatures of 18-20°C. [64·4–68°F.] arise deep in the bulk, infestation develops despite low external temperatures, and the temperature at the centre of the infestation rapidly rises and becomes lethal to the insects. Conditions are more favourable in the surrounding grain, however, and here development is rapid and the infested area thus extended. In a mass of heating grain that contained many living insects, chiefly *C. oryzae* and *Rhizopertha dominica*, F., at the surface and to a small depth, a temperature of 38·9°C. [102·02°F.] prevailed from a depth of 400 cm. (the lowest investigated) to within 100 cm. of the surface. Psocids were the only living insects found at these depths, but the presence of Coleopterous larvae and injured grains indicated that infestation had been present. Other data illustrating the progress of deep infestations are also included.

Superficial infestations, which, unlike deep ones, are fairly common in Great Britain, are shown to be of importance chiefly as a source from which deep ones can develop, since the heat produced by them cannot accumulate and the insects are unlikely to survive the winter.

Solomon (M. E.). **Behaviour of Tyroglyphid Mite Populations in stored Grain and Flour.** (Abstract.)—*Ann. appl. Biol.* **31** no. 1 p. 81. London, 1944.

Damage to stored grain by *Tyroglyphus farinae*, L., was found usually to be restricted to the destruction of the embryo, which significantly reduced the nutritive value of the grain. No deterioration was noticed when flour artificially infested 25 days previously, in which the final populations reached a density of 0·263 mites per 100 cc. flour, was baked. Tyroglyphids are almost ubiquitous ; they are spread by wind, birds, rodents or man, and the hypopial stages are adapted for distribution by insects and for resistance to unfavourable conditions. The moisture content of the grain is the most important factor influencing the distribution and density of the populations. The rate of reproduction varies directly with increase in humidity, and the mites do not survive in media in which the moisture content is lower than about 12 per cent., corresponding to an atmospheric relative humidity of 55–60 per cent. The optimum temperature range is generally about 18–25°C. [64·4–77°F.] ; the mites are resistant to low temperatures, but are destroyed by suitable exposure to temperatures of 40°C. [104°F.] and over. Populations of *T. farinae* increased rapidly in granaries during winter and spring, and decreased in summer and autumn owing to attack by the predacious mite, *Cheyletus eruditus*, Schr. This seasonal cycle was shown to be caused by the different effects of physical conditions on the two species.

Brown (W. B.). **The Role of the Chemist in Research on Fumigation.**—*Ann. appl. Biol.* **31** no. 1 pp. 81–84. London, 1944.

The author emphasises the importance of close collaboration between entomologists and chemists in studying the properties and methods of application of insecticides and illustrates his remarks with an account of the methods adopted in work on fumigants at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research at Slough, where the action of the fumigants on insects and their behaviour alone are studied separately by a predominantly biological staff and by chemists, respectively, the data later being combined. The chemical studies are made in

small-scale and commercial fumigations; where possible, observations are made on natural populations of insects, but the use of test insects is avoided. Outstanding features of the procedure are the determination at all stages of the work of the concentrations of the fumigant actually present, the use of a gas reservoir large enough to permit the accurate measurement of dosages and to render unimportant the loss of fumigant on rubber connections, etc., and the determination of toxicities for exposures as long as 18, 24 or 48 hours and at temperatures of 20°C. [68°F.] or less, which are comparable with the conditions under which commercial fumigations are carried out in Britain. As the product of the concentration of a given fumigant and the time of exposure required to give 100 per cent. mortality of a given insect [*cf.* *R.A.E.*, A **23** 121] shows some variation over a wide range of exposure times, it is important in correlating data obtained in the laboratory with the products of concentration and time observed in practical fumigation that the periods of exposure should be of the same order in each case. The concentrations of the fumigant are determined by collecting a known volume of the air containing it in an evacuated vessel and either mixing this with an absorbing solution, which is then analysed, or transferring it to a gas-volumetric apparatus or passing it through an additional decomposition and absorption system. This method is applicable to many different fumigants under a wide range of conditions and facilitates the collection of a large number of samples in a short time; it has many advantages over the usual method of aspirating a known volume of air through bubblers containing absorbing solutions.

By making small-scale tests on any given commodity, throughout which, and extending through the airing period, the concentration of the fumigant in the free space and at various depths in the commodity is constantly determined, and then comparing the concentration-time products with the concentration shown by the toxicity data to give complete control, allowance can be made in making recommendations for commercial-scale fumigation for absorption by the wrappings of the commodity and the length of time required for the fumigant to penetrate into and pass out from it. The relative rate of penetration by and rate and amount of absorption of various fumigants are determined by comparisons of the concentration-time curves for a given point within the commodity under consideration and those for the free space surrounding it. Data based on observations on test insects in the absence of determinations of gas concentrations are unreliable, since the mortalities obtained give no indication of the behaviour of the fumigant throughout the exposure period and different batches of insects of the same species show considerable variation in resistance. The great importance of absorption in practical fumigation, a problem to which much attention is being devoted at Slough, is neglected if recommendations are expressed as weight of fumigant per 1,000 cu. ft. space without taking account of the character of the commodity under treatment and the amount of space it occupies. In some cases, basing the amount of fumigant on the weight of the commodity is more satisfactory, but the best method is to allow a certain weight of fumigant per ton of commodity and an additional weight per 1,000 cu. ft. unoccupied space. This procedure has been successfully adopted in Britain for the fumigation of dried fruits, wheat, flour, nuts and other products with ethylene oxide.

Parkin (E. A.). **Control of the Granary Weevil with finely ground Mineral Dusts.**—*Ann. appl. Biol.* **31** no. 1 pp. 84–88, 8 refs. London, 1944.

Laboratory work on the value of inert mineral dusts in the control of insect pests of stored grain carried out at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research over a period of three years is summarised and the results discussed. These materials are in contact with the

grain and should remain effective over a long period, have no deleterious effect on the milling properties or germination of the grain or the flavour of flour prepared from it, and can be applied by unskilled labour or simple mechanical means, but their presence hinders the free-running properties of the wheat and the assessment of its quality, and intensifies the dust cloud formed when it is handled. Laboratory and small-scale trials by other workers, the conclusions from which regarding the value of the dusts for use on a large scale are not in agreement, are briefly reviewed.

Each of a number of mineral dusts available in Britain in war-time was tested on batches of 100 adults of *Calandra granaria*, L., 3–4 weeks old, that were confined in 100 gm. wheat previously mixed with 1 per cent. by weight of the dust. The most promising materials appeared to be felspar, dolomite and silica, but work on silica preparations was discontinued, owing to the inherent risk of silicosis. The rate of action of the dusts was found to be increased by the disturbance to the insects during mortality counts, and the intervals between examinations in any one experiment should therefore be kept constant or individual jars of a series should be examined once only at selected intervals ; the rate of action in grain that is not frequently disturbed is likely to be slow. Weevils were least resistant in the week following emergence, and most resistant in the third and fourth weeks ; there was a slight decrease in resistance in the next two. There was no significant difference in the resistance of the sexes, and the immature stages within the grain were unaffected. In a test in which flint, felspar, limonite [a hydrated ferric oxide] and anhydrite [anhydrous calcium sulphate] were used against *C. granaria*, *Tribolium confusum*, Duv., *Rhizopertha dominica*, F., and *Oryzaephilus surinamensis*, L., flint was found to be the most effective against all four species, and *O. surinamensis* was the most susceptible to all four dusts. Indications were obtained that the order of effectiveness of a number of dusts changes with the species of insect used. *Tyroglyphus farinae*, L., is very susceptible to finely-ground mineral dusts, but, where it is abundant, the relative humidity of the atmosphere is often too high for effective control.

No clear evidence was obtained of a relation between chemical composition and insecticidal action. In general, increased concentration accelerates the action of the dust, but the relation between the factors involved varies for different dusts ; in those in which the particles vary widely in size, the most effective particles are probably those less than 10μ in diameter, and the concentration of this fraction may be of greater importance than that of the dust as a whole. Equal control should be given by a low concentration of a fine dust and a higher one of a coarse dust. Of six sedimented fractions of quartz dust in each of which the range of particle-size was very narrow and the approximate mean diameters were 0·5, 1·8, 3·2, 5·5, 10·0 and $15{\cdot}0\mu$, the dust in which the mean diameter was $1{\cdot}8\mu$ was the most effective, at a concentration of 1 per cent. by weight, against *C. granaria*, and the loss in weight and mortality in starving weevils that were treated with the dusts were also greatest with this material. Down to a limiting degree of subdivision, effectiveness increases with fineness, and in very effective ground dusts with normal particle-size distributions the proportion by weight of particles larger than 30μ is negligible. A long period of grinding may reduce insecticidal efficiency, possibly owing to the introduction of other factors, such as the shape of the particles or a change in the surface structure [*cf. R.A.E.*, A **32** 39]. The effectiveness of dusts of the same particle-size increases with hardness [**32** 38] ; this may be because hard materials tend to yield angular particles, though some amorphous materials such as flint and precipitated colloidal silica are also very effective. The cost of grinding also increases with hardness. The rate of action of a micronised felspar dust decreased rapidly with increasing humidity and at 100 per cent. relative humidity it was ineffective ; at 70 per cent. humidity and temperatures varying

between 10 and 30°C. [50 and 86°F.], the rate of action varied directly with the temperature. The effectiveness of the dusts was not impaired by application to grain and storage at constant temperature and humidity for up to six months.

As a precautionary measure, uninfested grain can probably be deposited on a floor thickly sprinkled with dust and the surface covered with a thick layer of it, but where infestation is suspected, the dust must be intimately mixed with the grain by means of a shovel or rotating drum mixer in the case of small quantities of grain, or, in the case of large bulks, by introducing it at a measured rate into the grain stream just before its deposition on the storage floor. A trial showed that the dusts are readily removed by the ordinary cleaning process. The presence of dusts such as anhydrite, felspar and dolomite in the organic detritus removed during cleaning need not prevent the use of the latter in the preparation of animal feeding stuffs, since the concentration after the incorporation of other materials would be very small.

The mode of action of the dusts on insects is not understood and is probably the result of several factors. In a discussion of the various theories so far put forward, it is pointed out that although the accumulation of dust in the intersegmental membranes and joints of the limbs hinders movement and probably also mating and oviposition, this is not a primary cause of death. If the mouthparts are completely blocked, death ensues from starvation, but this also is not a primary result of the dusts, since dusted weevils succumb more rapidly than undusted in the absence of food. Dusted weevils lose weight faster than undusted owing to a reduction in their water content, and this takes place most rapidly under dry conditions. The author has shown that this loss is not due to an increase in surface area, caused by the adherent dust [*cf.* **18** 664 ; **32** 39], nor to the penetration of the intersegmental membranes by the particles with subsequent loss of haemolymph, and states that there is no evidence that liquid water can be drawn through the cuticle by non-hygroscopic dusts [*cf.* **24** 342]. It has also been demonstrated that no increase occurs in the rate of metabolism in dusted insects. He attributes the action to the interference of the continuity of the water-retaining lipoid layer of the cuticle by adsorption on to the dust particles.

Davidson (J.). **Wheat Storage Problems in South Australia.**—*J. Dep. Agric. S. Aust.* **44** nos. 3, 5, 7–8 pp. 124–136, 243–247, 346–352, 391–395 ; 23 figs. Adelaide, 1940–41.

Wheat in South Australia is normally stored in bags, but is ground or exported within a few months. Under war conditions, however, it may have to be stored for years, and the bags containing it are therefore being kept in stacks at depot sites. The stacks, which are usually 73 ft. wide and about 19 ft. high on the higher side, have 6-ft. breaks at 100 ft. intervals in their length. They are built on dunnage, surrounded by a mouse-proof wall, and are protected from weather by a sloping corrugated iron roof and side curtains of sacking that do not come in contact with the bags. In view of the risk of infestation by insects, notes are given on the bionomics and appearance of the sixteen more important species in South Australia, where the primary pests are *Calandra granaria*, L., *C. oryzae*, L., and *Sitotroga cerealella*, Ol. *Rhizopertha dominica*, F., almost comes into this category, and the results of workers in various countries on the environments produced by stored wheat and in wheat stacks and their influence on grain pests are reviewed and correlated.

In South Australia, the moisture content of ripe wheat at harvest probably averages 9 per cent. under normal weather conditions, but it increases during the autumn and winter, when atmospheric humidity is high. It fluctuates with changes of atmospheric temperature and humidity, but since wheat in stacks is

not freely exposed to the air, it does not react to changes of short duration. The respiration of the grain is slow at air temperatures up to 77°F. and increases up to 131°F., when harmful effects set in and the amount of carbon dioxide produced declines. In stacks, this gas accumulates between the grains and between the bags to an extent dependent on the amount of ventilation, and when concentrations become high, the rate of respiration of the grain is depressed. When the moisture content of the wheat is about 14·78 per cent., respiration is accelerated and the moisture content increased still more, which favours infestation by insects. As the moisture content of ripe wheat in South Australia is low, it is important to store grain in such a manner that this low level is maintained. In dry climates, which are normal in South Australia, the low atmospheric humidity is able to maintain the moisture content of the wheat below the critical point at which respiration is increased, and ventilated stacks are desirable, provided that the exposed surface area is relatively large and the depth through which the air must pass is small ; but where atmospheric humidity is high, non-ventilated stacks in which the carbon dioxide can accumulate appear to be desirable, if the gas is effective in preventing spoilage [*cf. R.A.E.*, A **7** 384].

In addition to the moisture content of the wheat, infestation and spoilage are primarily related to the temperature of the grain and to the percentage of carbon dioxide in the air of the stack, which in the type at present in use is estimated to occupy 42 per cent. of the total volume. The air between the outer bags is directly influenced by changes in the outside air, but that between the inner bags of an unventilated stack is affected largely by the temperature, moisture content and respiration of the grain ; air in the depths of the stack is unlikely to receive much heat from the outside air, since wheat is a poor conductor [*cf.* **32** 309]. Local heating may occur round bags containing wheat that has been exposed to the sun or damp or infested wheat, owing in the first two cases to more rapid respiration due to increased temperature and moisture, respectively, and in the third to the respiration of the insects. Grain and insects enclosed in air-tight containers are killed as a result of both decreased oxygen pressure and increased concentration of carbon dioxide, acting separately or in combination, even where conditions of temperature and humidity are favourable [**8** 178]. Considerable success has been obtained by enclosing stacks to render them as air-tight as possible so that the weevils are killed by the accumulated carbon dioxide. Adults of *Calandra* have been found to succumb within a few days when kept in an atmosphere with an oxygen content of less than about 10 per cent., and their rate of respiration is depressed in atmospheres in which the carbon dioxide content is more than 9 per cent. Adults of *C. oryzae* were shown by D. L. Lindgren in work already noticed [**24** 776] each to produce 0·267 mg. carbon dioxide in 24 hours when kept in wheat with a moisture content of 14 per cent. at a temperature of 77°F. It is estimated that, with an infestation of 1 adult weevil per 1,000 grains, the period required for the carbon dioxide in the air of the middle of wheat stacks, 100 ft. long, 65 ft. wide and built up to a height of 17 bags on one side and 23 bags (19 ft.) on the other, to reach a concentration of 10 per cent. is 9 days, that for a similar stack of uninfested wheat being 21 days ; the oxygen content at the end of these periods is assumed to be about 11 per cent. Observations in 1917–18 on infested stacks enclosed in malthoid showed that in nearly all of them the concentration of carbon dioxide soon rose to 10 per cent., and in some cases it reached 18·8 per cent.

Under favourable conditions of food and moisture, temperature is the chief factor influencing the activity and multiplication of the insects [**26** 336 ; **27** 118], and when this is favourable, moisture is the chief single factor ; the water available in wheat with a moisture content of less than about 9 per cent. has been found to be inadequate for both *C. granaria* and *C. oryzae* [**16** 252 ;

27 119]. Infestation is likely to progress rapidly in stacks in which the temperature exceeds 70°F. and the moisture content of the wheat 13–14 per cent. Immature stages and adults will survive when the moisture content falls temporarily below 10 per cent., the period of survival and the effect of the adverse conditions depending on the temperature and intensity of the dryness.

Precautionary measures to reduce risk of infestation are reviewed. They comprise the thorough cleaning of used bags and of bins and buildings used for storage purposes on the farm, the provision of a hard, even floor in storehouses and on storage sites, removing the bark from dunnage to eliminate shelter for the weevils, spraying the floors and walls of storehouses and dunnage with oil emulsion [**29** 540], and keeping the site immediately surrounding wheat stacks clear of materials likely to afford shelter to the weevils.

CROMBIE (A. C.). **On intraspecific and interspecific Competition in Larvae of graminivorous Insects.**—*J. exp. Biol.* **20** no. 2 pp. 135–151, 5 figs., 53 refs. London, 1944.

The following is substantially the author's summary. The females of both *Rhizopertha dominica*, F., and *Sitotroga cerealella*, Ol., oviposit in environments containing places suitable for larval development, but the larvae themselves, usually during a period of migration in the first instar, choose the actual developmental site. In each species the rate of oviposition does not bear much relation to the amount of food present for the larvae, and the latter do not refrain from multiple infestation of wheat grains. The competition that ensues is apparently wholly a struggle for space, the limitation of food or oxygen, and the " conditioning " of the medium [*cf.* *R.A.E.*, A **31** 124], being unimportant. Larvae (of any instar) will attack each other directly after encounters at random within wheat grains, and the supernumerary individuals are either killed or forced to migrate. The probability that any particular larva will survive is thus inversely proportional to the initial number present. Except that it tended to favour the survival of *Sitotroga* with atypical (retarded) rates of development [*cf.* **32** 72], overcrowding had no other effect upon the larvae of either of these species. In an unsaturated environment, migration may lead to survival; but when the environment is limited in capacity, a point will be reached when migration from one grain to another merely leads to death in another place. Then the only effect of overcrowding will be to increase mortality. Migration from the grains tends to decrease with later instars. Because of competition for space, the number of larvae of the same age that survive in one grain is less than that which the food present in the latter could support. This number (approximately 1·2 per grain) does not vary with density.

When the two species are competing, the average ratio of the survivors is *Rhizopertha* to *Sitotroga* as $1{\cdot}3\ r : s$, where r and s, respectively, are the initial numbers of larvae of each species. These represent the proportions of the 1·2 larvae surviving per grain that belong to each species. This ratio remains constant at all densities when the larvae enter the grains at the same time in the same instar. Each species thus decreases the probability of survival of the other in direct proportion to its own numbers.

When first-instar larvae of the two species enter the grains at different times, the relationship changes in favour of the first comer. The most unfavourable time for the second species to enter the grain is apparently when the first is in the second or early third instar. With greater differences between times of entry (*i.e.* of age), the severity of competition for space decreases, so that more larvae can survive and take advantage of the food reserves of the grain. The survival of the larvae of the second species is apparently then reduced to some extent by the accumulation of the excretory products of the first. *Sitotroga*, but not *Rhizopertha*, was able to take advantage of this decreased competition

because of the occurrence of larvae with atypical rates of development in this species. The latter were able to survive the competition of normal larvae of either species where other normal larvae would have succumbed. Crowding to a certain degree tended to increase the proportion of atypical larvae among the survivors of this species.

Overcrowding in the immature stages had no effect upon the average developmental period of the larvae, or upon the sex-ratio, weight or fecundity of the adults of either species.

Bentley (E. W.). **The Biology and Behaviour of *Ptinus tectus* Boie. (Coleoptera, Ptinidae), a Pest of stored Products. V. Humidity Reactions.**—*J. exp. Biol.* **20** no. 2 pp. 152–158, 8 figs., 13 refs. London, 1944.

The following is substantially the author's summary of this paper, which belongs to a series [*cf. R.A.E.*, A **31** 27, etc.]. Adults of *Ptinus tectus*, Boield., react to a humidity gradient by collecting in the drier region. The reaction to a given difference of humidity is most intense at low humidities; it declines to nothing at relative humidities of about 75–90 per cent. and increases again at 90–100 per cent. No such variation has previously been found. A kinetic mechanism of reaction is involved. The higher the humidity the higher the locomotory activity over a period of a week. Desiccated beetles are more active than normal ones. At low humidities they show a much weakened reaction towards drier air; at high humidities the normal reaction is reversed and they collect in the wetter region. Desiccated beetles given water to drink immediately begin to behave like normal ones. Some of the humidity receptors appear to be located on the antennae. Removal of the distal joint increases the intensity of reaction in high humidities, but the interpretation of this is questionable. The reaction remains strong when up to five joints are amputated and then it declines. When only 1–3 of the 11 joints remain, a reversed reaction occurs, similar to that shown by desiccated individuals. This suggests that there are two kinds of humidity receptors, the first kind being mainly situated distally on the antennae and some of the second kind being either on the basal joint or not on the antennae at all. Attempts to identify humidity receptors were not successful.

Plant Virus Diseases and their Control. Transactions of the Conference on Plant Virus Diseases, Moscow, 4-7/II 1940. [*In Russian.*]—$10\frac{1}{2}\times 6\frac{1}{2}$ ins., 340 pp., 67 figs., 7 diagrs., 10 graphs, 3 refs. Moscow, Inst. Mikrobiol., Izd. Akad. Nauk SSSR, 1941. Price 16 rub. 25 kop. [Recd. 1944.]

The following are, with one addition, abstracts of the papers in which insect vectors are discussed.

Sukhov (K. S.). **Zakuklivanie of Cereals and its Vector *Delphax striatella* Fall.,** pp. 68-81, 9 figs., 1 ref. Additional information is given on the bionomics of *Delphacodes* (*Delphax*) *striatellus*, Fall., the vector of the virus disease of cereals known as zakuklivanie, as observed in the environs of Omsk (western Siberia) in 1939 [*cf. R.A.E.*, A **29** 13, 14]. The virus overwinters in the nymphs, which hibernate, chiefly in the fourth instar and to a small extent in the third, in the harvested fields of millet (*Panicum miliaceum*) and late oats where they had hatched. In spring they migrate to grasses, particularly those along the borders of the fields. In many of the hibernating nymphs, the incubation period of the virus was not completed before May; thus, the percentage of infective nymphs rose from 20·3 on 18th April to 31·5 by 1st May when they had reached the fifth instar.

The abundance of the Delphacid in a given area was estimated by catching them in a cone-shaped box, open at the top and bottom, which had walls lined with cotton-wool and sloped at an angle of 30°, the lower (smaller)

opening covering a surface of 0·1 sq. m. The box was placed on the crop and the plants in it were shaken, which made the nymphs and the adults jump on to the walls, where they became entangled in the cotton-wool.

Severe outbreaks of the disease occurred in the region of Omsk in 1928–29, 1933 and 1937–39. The fluctuations in its incidence are probably connected with the abundance of the Delphacid in individual years, but the correlation is not simple because the percentage of infective insects in the populations also varies considerably in different years. Under field conditions in 1939, with up to 30 per cent. of the insects infective, 40–50 per cent. of the plants were infected when there were 200 Delphacids per sq. m. and only 4–10 per cent. when there were 70. Differences in sowing dates and ecological conditions appeared to affect the incidence of the disease only in so far as they affected the abundance and activity of the Delphacids. Drought favoured the latter and consequently the spread of the disease, but daily irrigation of the plots did not check it if the insects were numerous.

Brief descriptions are given of the adults of both sexes of the Dryinid parasite, *Pristogonatopus conjunctus*, Kieff. [*cf.* **29** 14] ; the female, which is apterous, was hitherto unknown. It oviposits in the abdomen of a nymph of *Delphacodes* and the larva develops in an external swelling. Only one usually develops in a single host, but two occasionally do so. Most of the hosts have reached the adult stage when the larvae emerge from them and die immediately afterwards. The larvae pupate in cocoons on the stems or leaves of the cereals, and the adults emerge in about two weeks. Hibernation takes place in the larval stage in the nymphs. The adult hosts can fly for considerable distances and thus assist the spread of the parasite.

Since no varieties of cereals have been found to be immune from the disease, the most effective method of control would be to break up the stubble of millet and late sown oats, on which the nymphs concentrate in masses, feeding on the green shoots or weeds, and follow this by autumn ploughing. Dense sowing and measures to maintain the density of the crop are also desirable, as the insects are attracted to fields in which the crop is sparse. The destruction of weeds that serve as food-plants in spring and autumn and may act as sources of infection is also of great importance.

Zakuklivanie is widely distributed in the Russian Union, occurring in the Far Eastern Province, Siberia, central Kazakstan, and parts of European Russia.

Vovk (A. M.). **New Data on the Zakuklivanie of different Cereals and their Hybrids,** pp. 82–106, 15 figs., 3 graphs. A detailed account is given of field experiments carried out in the summer of 1939 on the effect of mulching and watering on the incidence of zakuklivanie in oats. The oats were sown in mid-May and examined in June and August. The total percentages of plants infected and (in brackets) stunted on plots sown with 200 and 90 seeds per sq. m., were, respectively : 100 (91·7) and 100 (94) on untreated plots ; 99·8 (93·9) and 99·9 (97) on plots watered twice during the season ; 100 (92·9) and 100 (94·6) on plots mulched with peat ; and 77·6 (43·8) and 98·1 (69·7) on plots mulched with white paper. A subsidiary experiment indicated that mulching with black paper caused some reduction in infection and stunting, but the results were not strictly comparable as the densities of sowing in the treated and control plots were not the same. Measurements of the temperature of the soil showed that it had no effect on the disease. Counts of the numbers of *Delphacodes striatellus* on the plots used for the main experiment were made when the first generation was present, as this generation is the most important in the spread of the disease. The numbers per sq. m. on the dense and sparse plants were 206 and 129 in the untreated plots, 161 and 69 in those mulched with peat, 146 and 98 in those watered twice, and 57 and 50 in those mulched with white paper. A subsequent experiment in which the Delphacids were confined on one plot mulched with white paper and allowed to migrate naturally

to and from another showed that the paper tends to repel them, though the way in which it does so is not clear. The plants on plots mulched with either black or white paper, whether healthy or diseased, were more vigorous and gave larger yields than those grown in unmulched plots.

The results of experiments in which the disease was transmitted by *D. striatellus* from oats to wheat, rye, wheat-*Agropyrum* hybrids, maize, barley, millet and sorghum, and from wheat to oats and most of the other plants are summarised, and the symptoms in the various plants are described. The incubation period in all of them lasted 8–10 days. It is considered as proved that the mosaic of wheat that is widely spread in the Province of Omsk is identical with zakuklivanie, and is not the rosette disease recorded in winter wheat in the United States.

A survey in different parts of the Province in 1939 showed that the percentages of plants infected were 30–40 in barley, 20–50 in susceptible varieties of wheat and 10–15 in more resistant ones. The weight of the straw and the yield of grain were greatly reduced. Rye and millet showed only a very little infection.

Grebennikov (S. D.). **Pseudo-rosette Disease (Zakuklivanie) of Oats in Siberia and its Control,** pp. 107–119. Since the external symptoms of zakuklivanie in oats in Siberia and the Russian Far East are similar to those of the rosette disease of winter wheat in the United States, the author proposes the name of pseudo-rosette for it. He reviews divergent opinions of Russian workers on its cause and considers that it is probably due to a virus transmitted by *Delphacodes striatellus*. He suggests, however, that similar symptoms may be produced by other causes, as he observed profusely tillering rosettes of oats as a result of external injury to the tillering node by Elaterid larvae. He also found that stunting is promoted by the introduction of weak acids into the tillering nodes or by sharp fluctuations of the temperature and humidity of the soil. From a study in 1934–39 he concludes that, whatever its cause, its incidence varies with soil conditions and manuring programmes and is reduced by vernalisation of the seed. Outbreaks commonly occur when the density of the plants has been reduced by wireworms. Wireworms are not the direct cause, however, as, in an experiment, oats showing rosettes as a result of damage by them eventually produced panicles, whereas plants infected with pseudo-rosette do not.

Bruizgalova (V. A.). **On the Problem of Zakuklivanie of Oats in Conditions of the Baikal Region,** pp. 120–132. A shorter version of this paper has already been noticed [**30** 241]. In the Baikal Region, the nymphs of *Delphacodes striatellus* hibernate chiefly in the third instar, though a few do so in the second. Their numbers were greatly reduced by burning oat stubble in spring.

Zazhurilo (V. K.) & Sitnikova (G. M.). **Mosaic Disease of Wheat and other Cereals, its damaging Effect and Spread,** pp. 153–164, 1 graph. Most of the information in this paper on the mosaic disease transmitted by *Laevicephalus* (*Deltocephalus*) *striatus*, L., in Voronezh has already been noticed [**29** 15, 617 ; **30** 581]. The virus is compared with that of zakuklivanie and named winter-wheat mosaic, as winter wheat is its chief host-plant. The virus of zakuklivanie overwinters in the hibernating nymphs of *Delphacodes striatellus* and occurs chiefly in parts of Asiatic Russia where winter cereals are not grown, though it has also been found in several parts of European Russia, including the Province of Voronezh. The virus of winter-wheat mosaic, on the contrary, hibernates in infected plants ; its Jassid vector overwinters in the egg stage, and preliminary experiments demonstrated that the virus is not transmitted hereditarily through the eggs. It appears, therefore, that its distribution must be closely connected with that of winter wheats.

Moskovetz (S. N.). **Virus Disease of Cotton and its Control,** pp. 173–190, 3 diagrs., 1 fig. A virus disease of cotton that has been spreading rapidly in

Azerbaijan since 1934 appeared at first to be the leaf-curl of cotton [*Ruga gossypii* of Holmes] that occurs in the Sudan and is transmitted by the Aleurodid, *Bemisia tabaci*, Gennadius (*gossypiperda*, Misra & Lamba) [*cf.* **19** 708, etc.]. The author concludes, however, that the two diseases are distinct, since they cause somewhat different symptoms, the varieties of cotton resistant to them are not the same, and *B. tabaci* has not been recorded in Azerbaijan, and he proposes the name of " cotton curliness " for the Azerbaijan disease. In various experiments, it reduced the number of bolls formed by the plants by from 12 to 73 per cent., the reduction varying with the severity of infection and the period in the season at which it occurred. The susceptibility of the plants differed with the variety and locality ; in the six varieties tested, the average reduction in yield ranged from 16·2 to 55·6 per cent. The length and strength of the cotton fibre and the weight of seed were also reduced.

In experiments in which possible vectors were allowed to feed for five days on infected cotton plants and then for five days on healthy ones, *Aphis gossypii*, Glov., *Myzus persicae*, Sulz., *A. laburni*, Kalt., and the mite, *Tetranychus telarius*, L. (*Epitetranychus althaeae*, v. Hanst.) transmitted the disease to 85–100, 12·5–25, 6·1–16·6 and 7·7–10 per cent., respectively, of the plants exposed to them, but *Lygus pratensis*, L., and a Jassid did not infect any. The incubation period in the plants was 35–56 days. In tests with *A. gossypii*, older plants were less readily infected than young ones, but the incubation period in them was shorter, probably because the temperature of the air and soil was higher when they were exposed to infection. The virus was successfully transmitted to Egyptian and American cottons (*Gossypium barbadense* and *G. hirsutum*) by *A. gossypii* or by infusing infected sap into stems from which the tops had been removed. Somewhat different symptoms were produced by Aphid transmission in *Hibiscus cannabinus* and *Solanum dulcamara*.

In Azerbaijan, *A. gossypii* and the other Aphids that transmit the virus bred during the winter on weeds, particularly on wild mallow (*Malva*), which is commonly infected with mosaic. It is suggested that the cotton virus persists in the weeds and the Aphids on them throughout the winter ; weeds that show evidence of infection may be symptomless carriers and a source of Aphids infective to cotton in spring. These are not the sole source of spring infection, however, as other experiments showed that the virus can be transmitted through some of the seeds of infected cotton plants.

It was also observed that the rate of infection is greater if the plants are sparse. In plants sown on a series of dates from April to July, it increased progressively with delay in sowing ; this finding has no practical application, as cotton is not sown in May–July, but is further evidence that transmission is favoured by warmth. The resistance to infection of different varieties of cotton is discussed, and further selection of such varieties is recommended. More immediate measures comprise the use of seed known to be free from infection, the destruction of infected plants before infection has time to spread in a field, and the systematic application of insecticides against the Aphids.

Ruizhkov (V. L.) & Ovcharova (T. P.). **Anatomical Changes in Cotton caused by Leaf-roll Disease,** pp. 191–196, 5 figs. The structural changes caused in cotton plants by the virus disease found in Azerbaijan [see preceding abstract] are described and compared with those caused by the leaf-curl of cotton in the Sudan. The authors propose the names leaf-roll of cotton for the disease, since the leaves roll upward, and *Gossypium* virus 2, Verderevsky, for the virus (according to the classification of K. M. Smith [**26** 68]).

Khuduina (I. P.). **Virus Diseases of Tobacco and Makhorka in the USSR and their Control,** pp. 203–218. An account is given of the symptoms of numerous kinds of virus diseases that occur in tobacco and makhorka [*Nicotiana rustica*] in the Russian Union, and of experiments on their transmission.

They include certain forms of cucumber mosaic [varieties of *Marmor cucumeris* of Holmes] and a virus possibly identical with spotted wilt [*Lethum australiense* of Holmes], and these are the only ones with which insect transmission was tested. The cucumber mosaics are divided into two sub-groups, " white pickle," which was transmitted through the seed of tobacco, and cucumber mosaic, which was not. The latter was transmitted by *Myzus persicae*, Sulz., in one series of tests, but not in another; and in two years' experiments with white pickle, 65·8 per cent. of the plants exposed to transmission by this Aphid became infected, as compared with 11·1 per cent. of the controls. The virus possibly identical with spotted wilt was found to be transmitted by *Thrips tabaci*, Lind.

CHAKRAVORTI (S.). **Formaldehyde as a Preventive against Bookworm.**—*Sci. & Cult.* **9** no. 6 pp. 251–252, 4 refs. Calcutta, 1943.

The use of formaldehyde as a fumigant against insects infesting books and papers has been suggested, but the author points out that, apart from its doubtful effectiveness, it tends to harden papers and make them brittle, particularly if they have been sized with gelatine. Moreover, it may be oxidised into formic acid, which may affect the durability of the paper.

HOWARD (N. F.), WEIGEL (C. A.), SMITH (C. M.) & STEINER (L. F.). **Insecticides and Equipment for controlling Insects on Fruits and Vegetables.**—*Misc. Publ. U.S. Dep. Agric.* no. 526, 52 pp., 13 figs. Washington, D.C., 1943.

This paper consists chiefly of a list of ingredients for insecticides used against pests of fruits, vegetables and flowering plants, arranged in alphabetical order, with information on their sources and the ways in which they are used. Notes are also given on the method and time of application of sprays and dusts and the quantities necessary, the precautions to be taken in using insecticides, the removal of injurious residues from the crops, and the prevention of insecticidal damage to the plants, and a section dealing with spraying and dusting equipment is included.

SIEVERS (A. F.) & HIGBEE (E. C.). **Plants for Insecticides and Rodenticides.**—*Foreign Agric. Rep. U.S. Dep. Agric.* no. 8, [2]+20 pp., multigr., 43 refs. Washington, D.C., 1943.

A list is given of twelve plant products used as insecticides or insect repellents and two used as rodent poisons, with information on the names and distribution of the wild or cultivated plants from which they are obtained and the parts of the plant used; their commercial uses, sources and importance are discussed and methods of propagating, cultivating and harvesting the plants, their preparation for market and the yield obtained are described in some cases. Some of the products included are of well-known value against insects, whereas others are popularly considered to be effective, but have not been subjected to scientific investigation.

PAPERS NOTICED BY TITLE ONLY.

FATTIG (P. W.). **The** *Phyllophaga* [*Lachnosterna*] **or May Beetles of Georgia.**—*Emory Univ. Mus. Bull.* no. 2, 32 pp., 5 refs. Emory University, Ga., 1944.

BLANCHARD (E. E.). **Un nuevo Dexiido,** *Ceracia subandina*, **parásito de la tucura,** *Dichroplus arrogans*, **Stål.** [*Ceracia subandina*, sp. n., parasitising *Trigonophymus arrogans*, Stål, in Rio Negro, Argentina.]—*Rev. Soc. ent. argent.* **12** no. 1 pp. 19–21, 1 fig. Buenos Aires, 1943.

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